0153

LONG RANGE FACILITIES PLANNING

IHI SURVEY

VOL, IV OF V

NATIONAL STEEL AND SHIPBUILDING COMPANY
A MORRISON-KNUDSEN COMPANY

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NATIONAL SHIPBUILDING RESEARCH PROGRAM

SP-1 FACILITIES PANEL PROJECT

LONG RANGE FACILITIES PLANNING

IHI SURVEY

VOL. IV OF V

NATIONAL STEEL AND SHIPBUILDING COMPANY

IN COOPERATION WITH THE

DEPARTMENT OF TRANSPORTATION

MARITIME ADMINISTRATION

APRIL, 1982

IHI SURVEY

Volume IV

TABLE OF CONTENTS

STUDY REPORT ON SHIPBUILDING

FOR

NATIONAL STEEL AND SHIPBUILDING CO.

Volume I

- Accuracy Control of Hull Construction -

October, 1979

IHI

lshikawajima-Harima Heavy hdustries Co., Ltd.

TOKYO, JAPAN

CONTENTS

SURVEY REPORT ON THE PRESENT ACCURACY CONTROL SYSTEM AT NASSCO AND RECOMMENDATION FROM IHI

JUNE, 1079

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Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCT033

Table of Contents

PAGE

SURVEY REPORT ON THE PFESENT ACCURACY CO NTROL SYATEM AT NASSCO

1. INTRODUCTION

According to the contract concluded between NASSCO (National Steel and Shipbuilding Company) and IMT (IHI Marine Technology Inc.), a survey on the present Accuracy Control system at NASSCO was couducted by two (2) IHI engineers from May 7, 1979 through May 18, 1979. The study was designed to reveal problem that cause interruption in the smooth hull construction process at NASSCO. As the result of this study, and in accordance withi the contract, IHI made some effective recommendations.

Due to the coordination and cooperation of NASSCO managers and engineers, the survey was completed successfully.

The following documents are included in this report:

(1) Review on the present system of the Accuracy Control at NASSCO .

(2) Recommendartion for Accuracy Control from IHI.

(3) Introduction of IHI Accuracy Control System.

(4) The expected schedule for the 2nd survey.

List of Reference Documents from IHI

1) An extract of the SRAIS (The Shipbuilding Process and Inspecti
Standard) . . . .
Quality Control Standard (Hull Part)

2) Management for Hull Construction Defects ("F" series)

3) IHI Accuracy Control System (Description) Reffered documents:

(1) Accuracy Control - Chech point, Checking Dimensions, Checl
Method based on fabrication sequence for Future - 32 bulk
prepared by IHI.

(2) Accuracy Control Check Sheet for Future - 32 Bulkers - pre
pared by IHI.

(3) Accuracy Control - The scheme of the Added Materials and
Finishing Phase for the Future - 32 Bulkers at IHI.

(4) Standard and Tolerance for Keeping High Accuracy at IHI A
Shipyard, prepared by IHI.

4) Hull Block Construction at IHI Kure Shipyard.

5) Base line to be effective for keeping high accuracy included i
the output through engineering and lofting

The Purpose of the Accuracy Control

For better understanding, it is necessary to state the purpose and the meaning of Accuracy Control.

IHI considers that Accuracy Control is a system to be supported by all organizations of the shipyard from Engineering, Mold Lofting, Marking, Gas Cutting, Bending, Welding, Sub-assembly, Assembly and Erection. The Accuracy Control system is a series of activities designed to assist the shipyard in constructing high quality ships in a safe manner, at a low cost, with increased productivity. In that sense, the terminology and definiton of “Accuracy Control" is distinguished from “Quality Control" or “Quality Assurance” .

Even though there may be many approaches of Accuracy Control, IHI considers that the most important facet in hull construction is to maintain high accuracy in the shape of hull units at the erection stage. In other words, the idea is to minimize work at the erection stage by concerted effort in the preceding phases of assembly, sub-assembly, fabrication and engineering including mold lofting. If the unit is improperly constructed in any one of the previously mentioned phases, considerable rework results at the time of erection. Many of these mistakes will need rework, thereby resulting in hazardous and inconvenient working conditions.

It must to be recognized that the accuracy at erection is a result of **accuracy in the steps preceeding erection,** such as marking cutting, ben fitting and welding. Moreover, the Engineering and Production Departmen should coordinatetiee their acclivities to produce more concrete methods and/ procedures for Accuracy Control.

Most importantly, all the activities for Accuracy Control should be syst tically continuous.

OC

2. REVIEW OF THE PRESENT SYSTEM OF THE ACCURACY CONTROL AT NASSCO

2.1 General View

The present system of Accuracy Control at NASSCO was reviewed by two (2) IHI engineers from May 7, 1979 through May 18, 1979. The study covered the Engineering Department, Mold Loft, Production Control and HuIl Construction Departments. There were two (2) main points in the survey. One was to obtain facts at the production level which would indicate the results of efforts in preliminary construction phases and the total ability. The other was to understand the "flow of the information and data to indicate how the ships are constructed."

Many aspects of advanced technology are in Practice, such as the computerized drafting machine; display terminals; NC plasma cutter, welding technology including automatic welding, assembling method on PIN/JIGS and others. Workmanship in the Production Department is considered to be good, if suitable guidance is provided.

However, through the observation of the actual production process during Hull Construction, several problems were found. Some of them are limited to the production practice itself, but ,most of them are related to the present system of communications and information flow from the

Engineering Department, Mold Loft, and Production Control to the Production Department. There are very few written NASSCO ship construction policy standards, and assignment of organizational res sibilities for aking, checking and controlltig such stabdards. Written procedures are seeded far coordinating the activities betwee shops concerned with hull construction. [redacted] a formal communication net work, the vital data for maintaining high accuracy, such as checking procdures, allowable tolerance, and decisions of excess material. become dependent on personal experience or a method unaucthorized by the organization.

With respect to the above, a summary of the general problems and the individual shop problems is presented by the IHI team in the followi paragraphs.

2.2 Summary of the Existing Problems

It is believed that almost all of problems found in production are caused by the following matters:

1) No written standard data on "excess" decisions.

No Wirtten excess Standard exists to Show the following rnatters:

(1) Why is excess necessary?
(2) Where is excess required?
(3) How much excess is necessary?
(4) Where is excess finished up?

For every ship, an excess plan for main strakes such as shell plates is designed by the production plannimg department, likewise excess is shown for other structure.
However, the excess plan is not governed by any basic written Standard (Philosphy).

Excess is now used as a "buffer" to compensate for all errors caused by each phase including Engineering. Threfore it is difficult to find the true cause errors and a way to improve the methods. "Too much excess" produces "Rugh check" and this requires "Too much excess".

(2) No written standard data for shrinkage allowance

The value of shrinkage caused by welding is different due to fabricating method and welding sequence. No clearly recorde for shrinkage or standard of shrinkage considerations exist.

(3) No clearly written standard for Base lines and Match marks

Though the necessity and importance of Base lines and Match is recognized and used, their location and length is require the Production Department.

(4) No written checking procedures nor allowable tolerances

It is necessary to establish a checking procedure in order to guarantee precision at each phase. However, no written chec procedures, or allowable tolerances exist. Therefore, there very few written records of measurement or feed-back.

(5) No drawn fabrication scheme for assembly

At NASSCO, the fabrication sequence for sub-assembly and ass is indicated by "Leveling" which is a part of a "piece mark system" and is put into the computer system. This system ma good enough to indicate the simple fabrication sequence for assembly, however, it is not adequate enough to indicate the vital points and vital dimensions for keeping high accuracy the process of assembly.

(6) Very few written standard practices for work and production

Due to very few standard practices for work and production, the output (result) from each phase cannot be kept in uniform quality. Scarcity in skilled workers is a big problem at NASSCO, and limited standard practices accelerates the personnel problem.

(7) Contribution of working drawings to Accuracy Control

Working drawings developed by. the Engineering Department show the details of the ship's hull structures and are used by the succeeding phases. The excess is not included in the working drawing. As already described, little guidance is provided to indicate a concrete fabrication method including vital points for measuring high accuracy. Keeping in mind that the working drawing is the only widely distributed official drawing which can display the total requirements of the ship's hull, the working drawing can constribute toward accuracy control by adding necessary information and data.

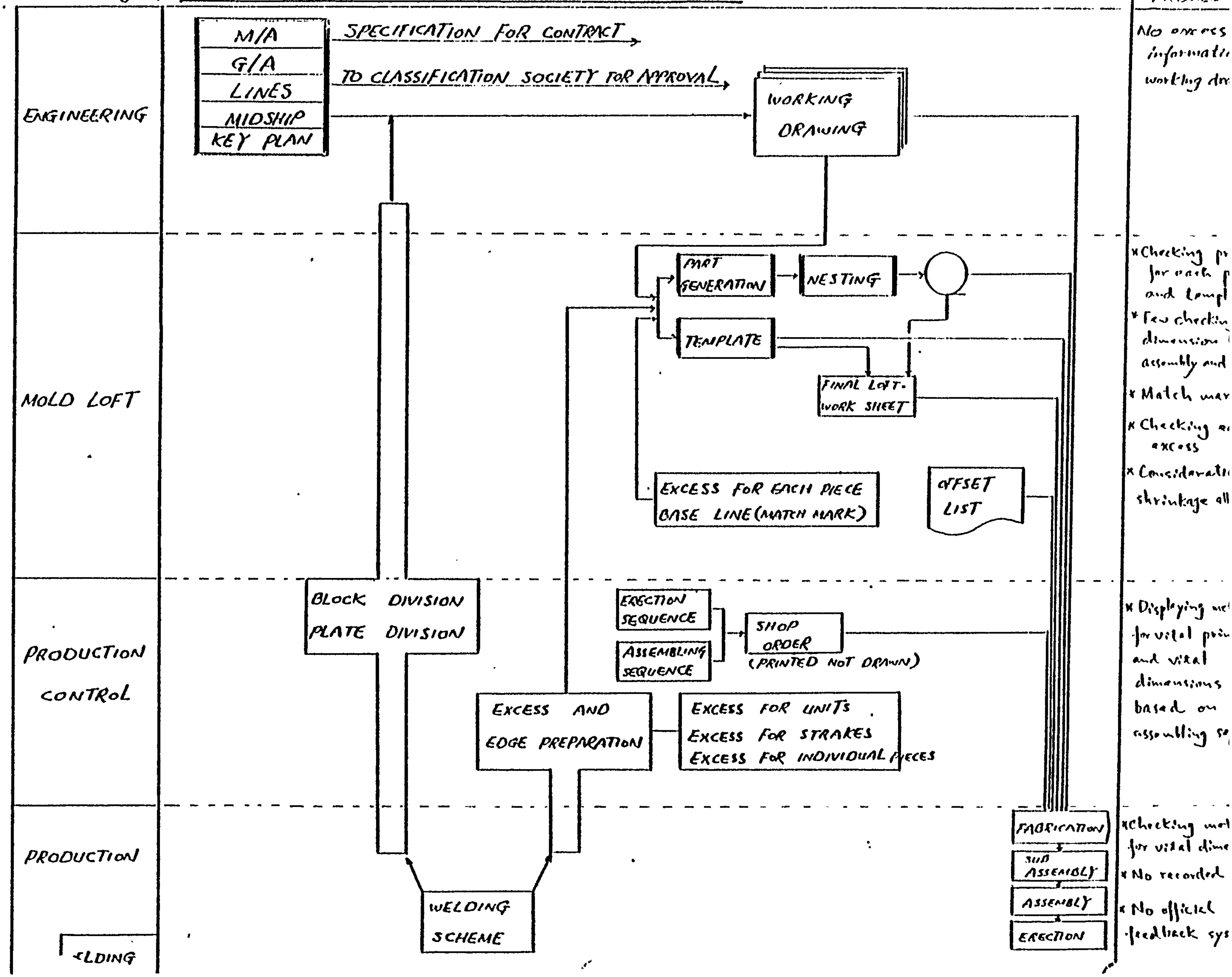
It is not American practice to put manufacturing instructions on a design drawing. Production engineering has this responsibility.

2.3 Actual problems found at each shop and comment from IHI

Through observation and discussions with NSSCO's personnel, the following flow chart of "Eull construction information and data flow was made by IHI engineers. (See Fig. 1). As shown in Fig. 1, there are some problems at each shop. The common problem to each shop is lack of a standard which officially states the exact method for comp tion of the activities in relation to the other shops. For welding, there are adequate manuals such as "Standard Welding Details" and "process Control procedure for Welding and Repair Welding". Welding one of the most vital aspects for "Quality Assurance".

The Following is a listing of the actual problems found at each shop and comments from IHI.

Fig 1. HULL INFORMATION AND DATA FLOW AT NASSCO



1) Enginering Department

As far as the design function of the Engineering Department in defining the detailed hull structure, there is no problem in particular. However from the viepoint that the working drawing should define how to construct a unit and how to build a ship, sore information is nceessary for production such as excess is required in the working drawing. The working drawing is the only official drawing issued to every shop at present. Therfore it is recommended that prodution engineerir drawing should be issued showing parts and assembly. If this information is shown in the working drawing, the checking procedure at each shop should be easily performed using the came media without any contradiction caused by misreading or use of another reference mannual or personal judgement.

2) Mold Loft

By virtue of its purposes, the Mold Loft should be the nuclaus for Accuracy Control activities. As shown in Fig. 1, most of tlm output used in actual production is generated by the Mold Loft. Since the shape of a hull piece is cut out of material from NC data and template, the information contained therein should guarantee the required accuracy of a piece and should include effective data for Accuracy Control .such as shrinkage allowance, base lines (match marks) and allowance for defor- nation. In other words, such information for production should be provided in advance.

The following problems have been found in the Mold Loft.

Ambiguous checking procedure

- NO specialized checker.
- what is the base for check?

  working drawing is inadequate for checking necessary data for accuracy control.

In the case of steel templates for places assembled at assembly, it should be checked in advance in order to compa the inter-relationships. between templates.

(1) **Shrinka**ge allowance is not considered. Shrinkage at the t of welding cannot be neglected. Even when excess is taken at the plate edge, fitting a web plate to a longitudinal frame, is difficult if shrinkage allowance is not consider at the welding seam between a longitudinal and a plate. I fact, some of cut outs at longitudinals were found to be c at assembly. This is only one example.

Concerning shrinkage, a recommendation from IHI is made Lat=-

(2) *Some match marks are* unsuitable. *Many* match marks are involved in the NC tapes and templates. However, those us at assembly were often unsuitable, because match marks punched by NC burning machine are too short for adjustment pieces being used by assembly personnel. It is easy to sna a piece at sub-assmbly while connecting marked points, however, it is difficult for workers to know which one sho be snapped. In this case, it is recommended that longer marking be accomplished by input to the computer system.

(3) On the templates, the plate edge is indicated by the designed position, and the excess is gives by numeric number. (Ex 1" → |) Therefore, marking the line to be cut to meet the excess requirment should be accomplished at the marking shop.

It seems more convenient to indicate directly the position of the excess on the templates as well as the designed position on the plate in order to prevent errors.

(4) No information such as bridgingg is indicated in the NC data, and templates, nor is information available for deformation prevention during the cutting procedures.

(5) Very few services are offered for dimensional checking at asssembly and erection. A full espy of the offset, such as frame offset, longitudinal offset and seam offset are issued to the production people; the necessary dimension need to be picked up by the Mold Loft so that the workers don't have to pick them up from the offset table themselves. Informed in this area should be provided by the Mold Loft.

3) Production Cantrol

The assembly sequence is decided by production control and transmitted in the form of a "Piecs level" as a part of the pie mark system. This method may be sufficient for the assembling process itself from fabrication through sub-assembly and assemb however, it is very difficult to indicate the vital dimfensions points in order to maintain a high degree of accuracy.

If the fabrication sequence is iadicated by a drawing, it would become easier to recall the vital points at the time of survey during the assembly process if the instruction for these vital points can be included in the drawing. This drawing should be provided as the common base used by each shop to indicate how t proceed with dimensional checking based on the assembly process Also the necessary input for NC data and templates can be performed by the Mold Loft referromg to this drawing.

4) <u>Fabrication (Gas Cutting, Bending)</u>

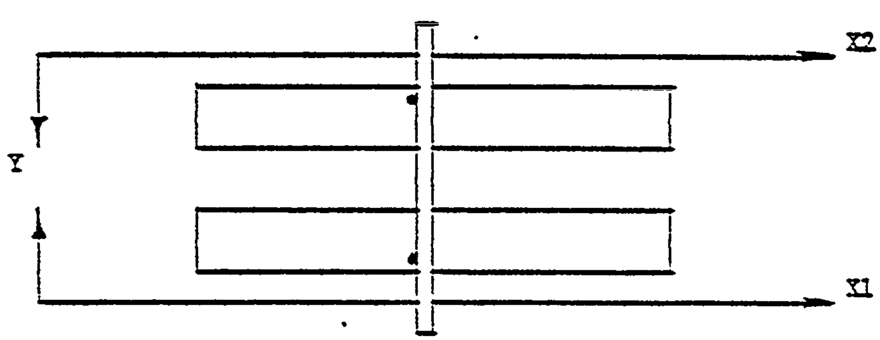
According to the machine operator at the NC burning machine, the results of burning errors are sometimes too obvious to overlook. Checking and maintenance of the machine is being regularly performed and a written record is being accumulated. What should be done now is to record the measured data.

* During the time of the last survey, two plates were measured as shown in the attachment papers. The error of 1/8" in the length of 37'-6 5/6" was detected in a square shaped piece. Another error of 1/8" in the length of 86" was found in a flange bracket. Those errors are considered to be excessive for an NC machine.

* Recommended checking procedure.
  For reference, IHI's method is introduced as follows:

  - For precise checking, a jig with a ball-point pen is attached at the marking torch.

  - Perpendiculary check of the torch girder (Y-axis) to the driving railways (X-axis). (Synchronize check).



o $\Delta X = 15'$ Marking by the ball-point pen or zinc

0 Then $\Delta X = -15'$ Marking

° Check the discrepancy of the two marked lines

Checking the rack pinion (lengthwise check)

o $\Delta X = 15'$ Marking

o Δ Then $X = -15'$ Marking

° **Measure the** both length marked line

Check the back lash

o $\Delta X = 10'$ Marking

o Then $\Delta X = -C_1$ (cl = 3/8″)

o Measure C_1

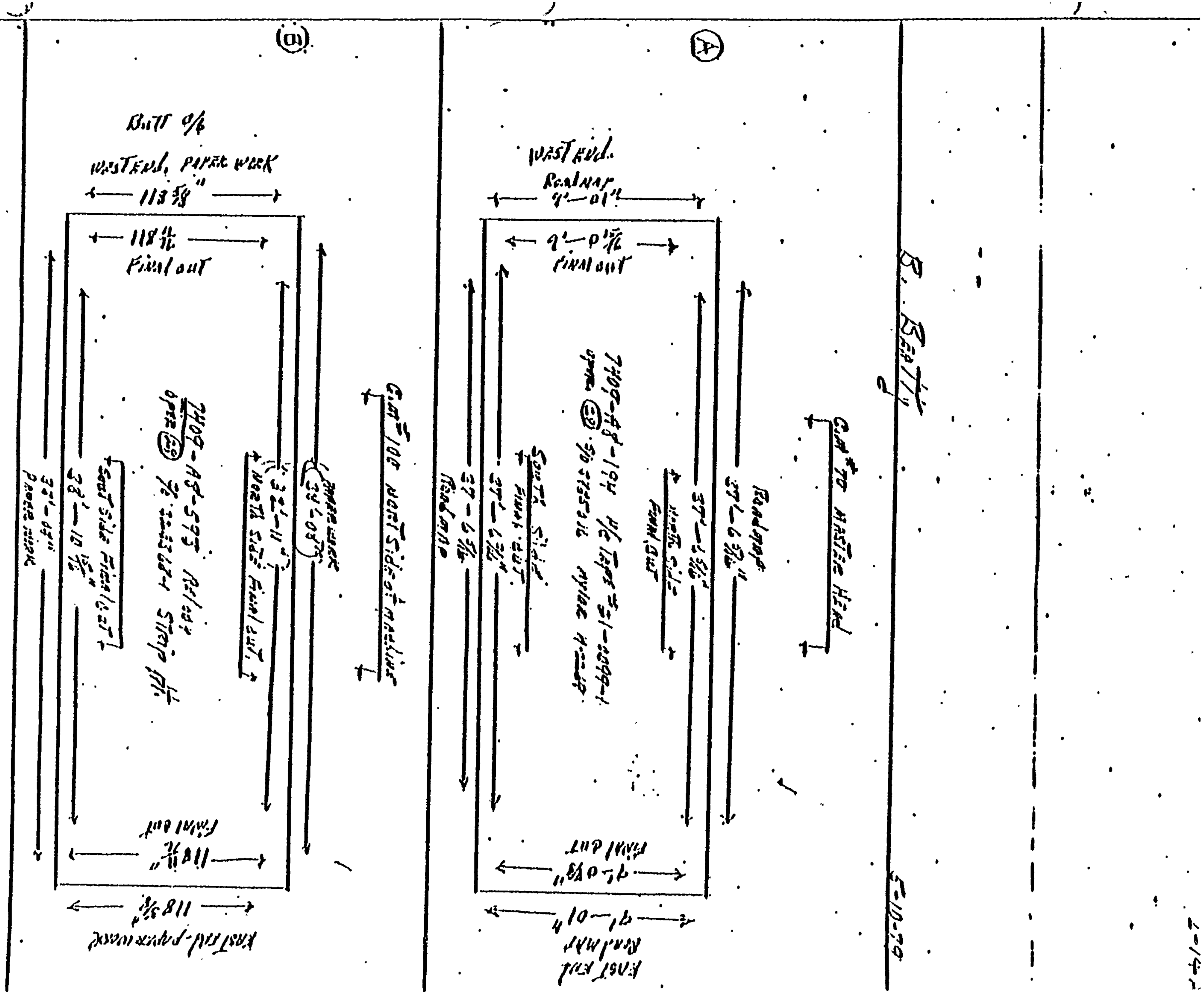
(I) **No** countermeasure **for** de deformation by **heat torsion** are considered.

Briding between piaces is not **considered.**

Pending-cut is not considered. As an example, at the part ***where beat is*** concentrated, the edge line with cut-cuts must be considered. For a piece with a nar width, pending-cue is also necessary.

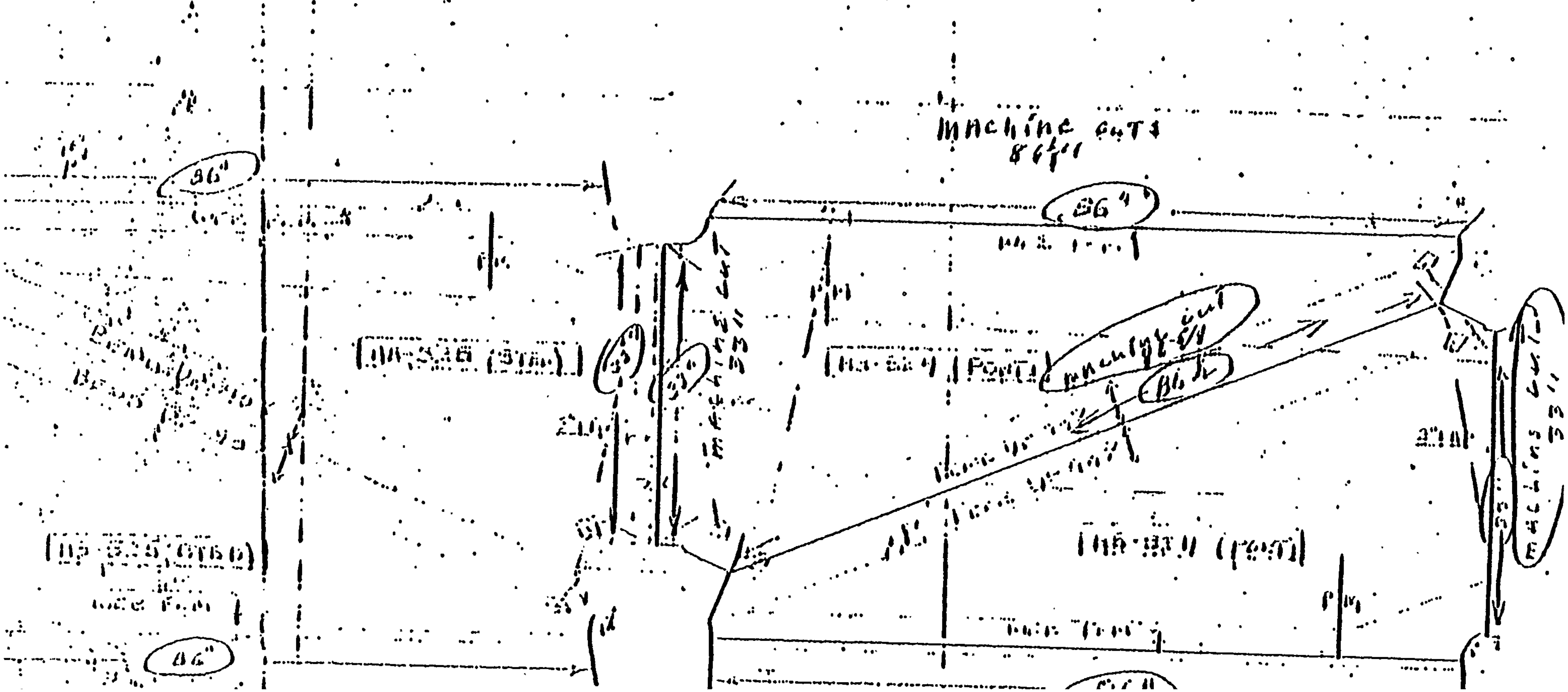
Long strip scrap should be cut in small pieces, becau its movement during cutting may cause some deformatio

(2) Frames bent by the method of hammering after heating in t furnace was found to be precise, however many flaws by ham mering could be seen.



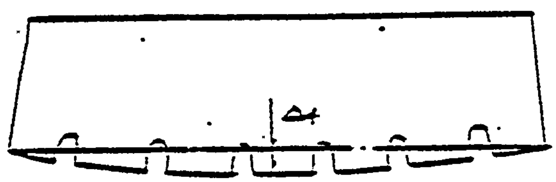
(B)
(A)
Butt o/s
WestEnd, Paper work
113 5/8"
118 1/16
Final out
West End
Roadmap
9'-0 1/4"
9'-0 1/16
Final out
Final out
118 1/16"
118 3/4"
East End-paperwork
Final out
9'-0 3/8"
9'-0 1/4"
Roadmap
East End
C.M #100 West Side of machine
C.M #70 Master Head
B. Beatty
5-10-79

BRKTS

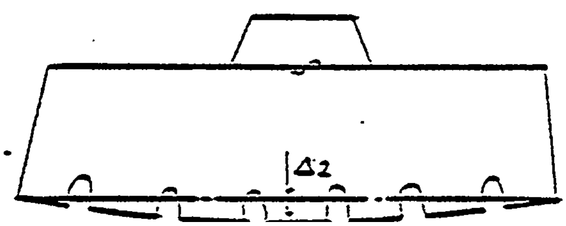


5) **sub-Assembly**

(1) When welding, shrinkage allowance is not considered. shrinkage and deformation due to butt welding of plates and fillet welding stiffeners to the web plate cannot be neglected. Actual shrinkage and deformation was found as shown in the sketches beloew, which was recorded during our stay. Another deformation was found in the other web plate.



Δ 1 = 1/4"
Measured after gas cutting



Δ 2 = 3/4"
Measured after plate welding

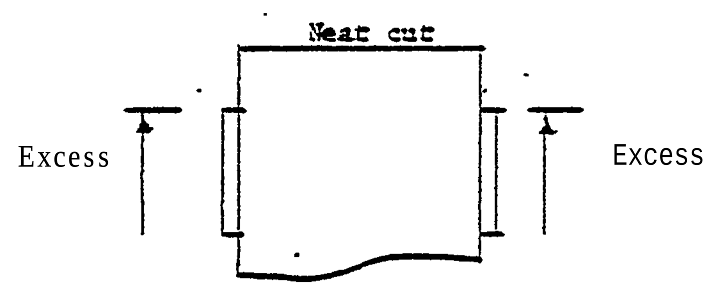
As shown in the above figires, defotmation of 1 (1/4") is presumed to be occuring during gas cutting because there is no bridging at the edge of cutouts. Deformation of 2 (3/4" ... 3/4"-1/4" = 1/2") was obviously caused by plate welding. If this sub unit is sent to assembly without reformation, fittiag this web to longitudinal frames and skin plate is not easy; the cutouts will often need to be cut.

In order to prevent this deformation, the following alternate method is effective.

Welding plates before NC gas cuting

After fitting all face plates and stiffeners to the plate, welding follows.

(2) Some excesses were found to be inconsistent.



of course, this is not the responsibility of sub-ssembly The problem lies in the fact that the inconsistancy is no found until subassemblies are assembled. The inconsisten is not noticable because the drawing does not detail the excess and the only place the information can be found is the NC data or on the template.

6) <u>Assembly</u>

(1) When welding, shrinkage allowance is not considered.

(2) Match marks marked in advance are not suitable. The match marks are too short and placed. intermittently, therefore fitting is not easy because the previously fitted structures hide it. A consideration for this problem necessary, as described in 2) of this paragraph.

(3) There is no written checking. procedure or idea of the vital dimension.

(4) Assembling curved shell unitj on PIN/JIG

- The foundation of PIN/JIG is poor.
- Supporting jigs are not set normally. (perpendicular to pin?)
- Positioning of places is very rough.
- Dimensions to be checked are not prepared. in advance.

The diagonal length of a unit is not prepared by Mold Loft.

(5) Lap connection between Longitudinals and stiffeners on a web.

Even in the parallel body, lap connection is adopted to compensate for the errors and misalignment. Lap connection is unsuitable from the viewpoint of strength at the connected part or for saving man power in welding.

(5) (Continued)

Taking into accout the workmanship at NASSCO, it will no difficult to change the method to butt and simple fillet Welding.

Introduction of IHI's experience on this subject is sign Cant. When IHI decided to abolish the lap connection more this 6 years ago, objection from production people, espe- Cially cially vetaran foremen, occurred. However, no par- ticular problems came about through the chage.

7 *Erection*

The shipwright method performed at NASSCO is much the same as *IHI's* method. A *shipwright* report is written both at the beginning and end of production (see the attached paper). However, since no written standard practice exists, the shipwright must depend on the experienced personnel. If the standard practice is written, technical transfer to the less experienced personnel will be facilitated.

One more problem is that the necessary dimensions for checking are not prepared by Mold Loft but calculated or derived from the off-see table printed by erection personnel. It is recommended that this data should be prepared by the Mold Loft.

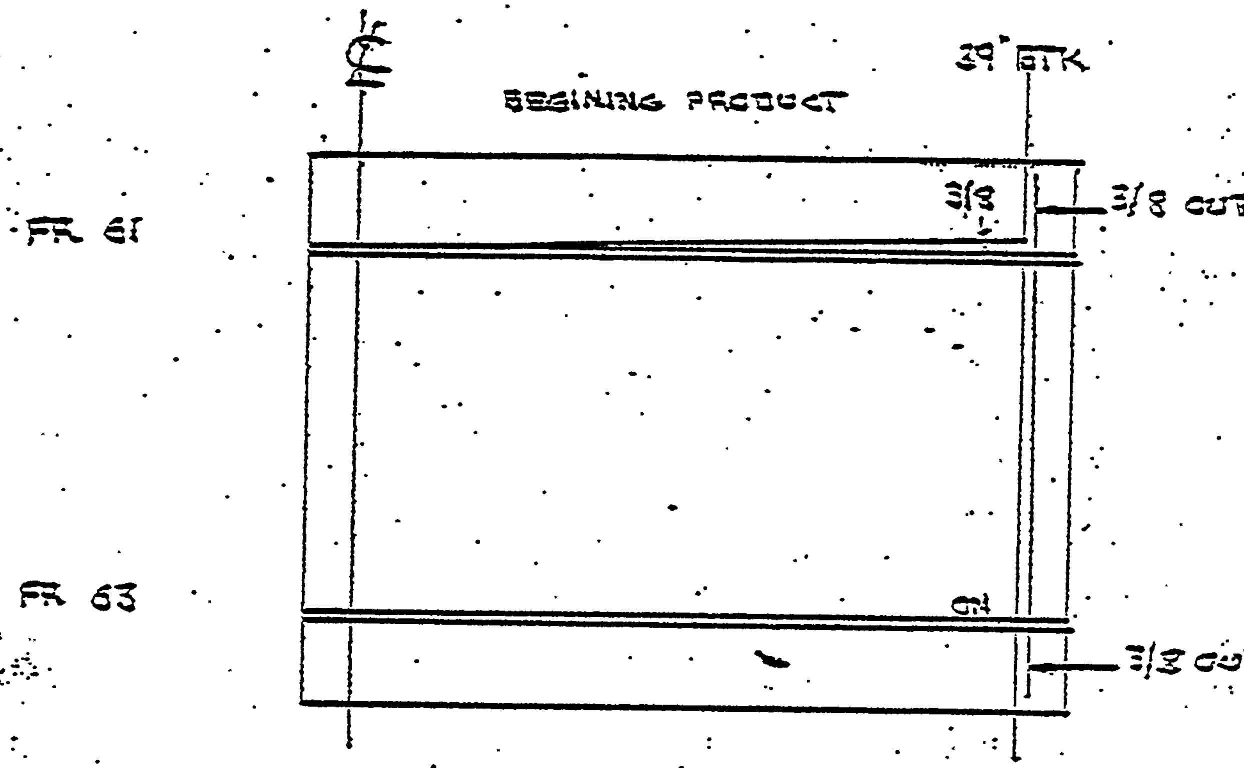
②

SHIPWRIGHT REPORT 3-1

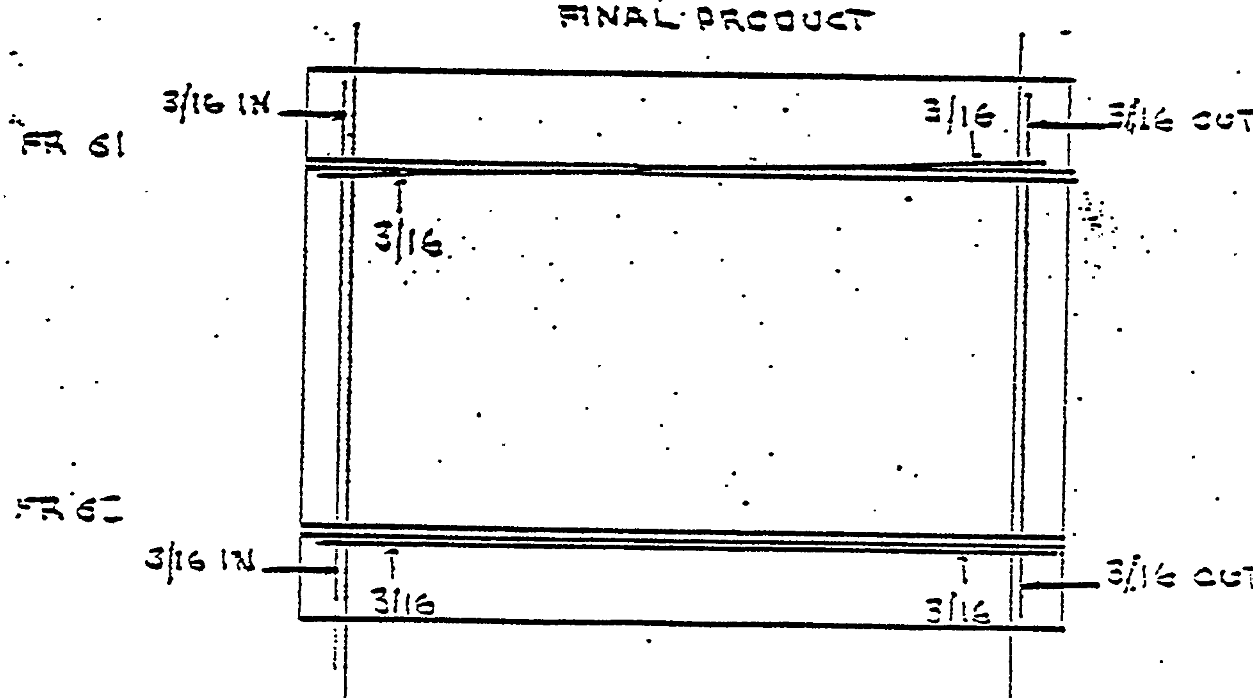
LOWER INNER SEQ A2-2 S/

HULL - 7409

BEGINING PRODUCT



FINAL PRODUCT



3. RECOMMENDATION FOR THE ACCURACY CONTROL FROM IHI

Cancerning the present Accuracy Cantrol system at NASSCO, the problems described in the previous chapter can be categorized into the following three (3) areas:

1) Quality Control Standard.

2) Excess Standard in consideration with Shrinkage Allowance.

3) Standard for production practices and working practices considering the flow of information and data.

The following are recommendations on the subject from IHI. Some IHI documents are referred to in connectioin with the recommendation.

3.1 Establishment of the Quality Control Standard of NASSCO

The first recommendation from IHI is to **establish a Quality** Control Standard. It should indicate the allowable tolerance levels in kee with the effort are and cooperation of every phase of the production pı cess. Also it should indicate corrective action in case an an erro exceeds the allowable limit. The Quality Control Standard covers t basic item of errors that occur in every phase of the production p cess, On special cases, supplemental additional description is necessary. It therefore follows that the Quality Control Standard *be* called **the "Constitution of Quality Control".**

Since the **Quality Control Standard indicates the allowable limits a** managing **method for errors, it can be said that the Quality control** Standard describes the potantiality of Quality Assurance at **NASSCO.** Upon introduction to the shipyard, Quality control Standards can be the **goal** of NASSCO activities. Through accumulation of the measure data for Quality Control, the potentiality and ability of Hull. Construction at NASSCO should be visible.

After establishing this system, it can be reffered to at any time o any place as the base of Hull Construction, through which the study improvement can be widely developed. In addition, if this standard approved by the classification society in total, it becomes unneces to be approved every time a new contract is signed.

3.1 Establishment of the Quality Control Standard of NASSCO (Continued)

IHI has established a similar standard called SPAIS (The Shipbuilding Process And Iuspection Standard). Some revisions are issued every year after auchorization by the classification societies and by the ship owners.

The following documents of IHI are attached for refernce.

(1) An extract of the SPAIS (The Shipbuilding Process And Inspection Standard) . . . . Quality Control Standard (Hull Part)

(2) Management for Hull Construcion Materials Defacts. ("F" series). This is to indicate the the procedure for hull construction of the "F-series" ship.

3.2 Establishment of Excess Standard in consideration with Shrinkze Allowance

Excess is one of the most essential factors to consider in the dimensional control of hull construction. Excess as a necessity should be deeply studied from the data and the experience of the shipyard. At present, excess is used to compansate for all errors which occur through the production process, and excess is always set at the edge plate. However, excess used to compensate for the shriakage when welding is very important for maintaining precise shapes of the total ship. It is necessary to cake into consideration the excess at the stiffener/ longitudinal frame space to compensate for shrinkage while welding as well as at the edge of place.

The method of handling excess at IHI is briefly presented as follows

1) Element of shrinkage

Shrinkage occurring through the production process can be classified into the following elements.

(1) Corrective action to maintain the shape of ship at erection

Shrinkage allowance for welding joints and reforming by line heating are defined through the experience.

1) Element of shrinkage (Continued)

(2) Allowance for fillet welding (A):

There should be a shrinkage allowance for fillet welding between internal members to the skin plate. The shrinkage is caused in the direction normal to the welded line.

(3) Allowance for reforming by line heating after assembling (B):

There should be a shrinkage allowance for reforming by line heating which is treated on the opposite surface of the skin plate along the welded internal memners after assembly. The shrinkage is caused in the direction normal to the welded line.

(4) Allowance for welding plate (E):

There should be a shrinkage allowance for welding plates in a block.

(5) Allowance for fillet welding at the internal member (a):

There should be a shrinkage allowance for fillet welding between stiffeners, such as flat bars and brackets, and a web plate.

(6) Allowance for reforming by line heating after sub-assembling (b):

There should be a shrinkage for reforming by line heating which is treated on the opposite surface of a web plate along the welded stiffeners.

1) Element of Shrinkage (Continued)

(7) Allowance for welding plates (a):

Shrinkage allowance for welding plates in an internal mem

(8) other elements

shrinkage allowance for welding and heating in a piece or block with a special shape.

2) Excess treatment

There are two (2) practical ways to handle excess derived from shrinkage allowance as listed above.

(1) Undivided whole excess at the edge of a block or a sub

The total excess required is set at the edge of a block a a sub without division. This method facilitates the dime sion at the marking phase, however, spacing of longitudin frames of the fabricated block become different from the designed.

(2) Separately distributed excess

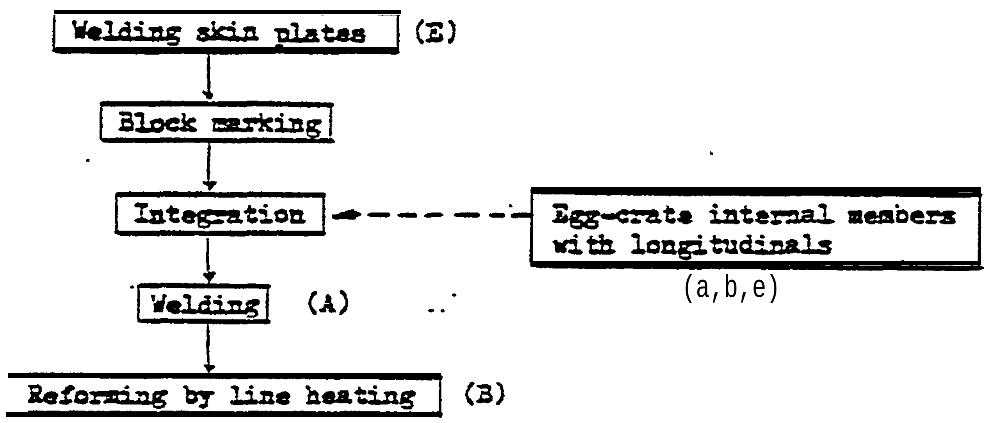
Corresponding to the characteristics of shrinkage, excess separated and distributed to the spacing of longitudinal mes as well as the plate edge.

This method makes it possible to fabricate a block or a s in the exact dimension as designed, however it is not eas to determine the dimension at the marking phase.

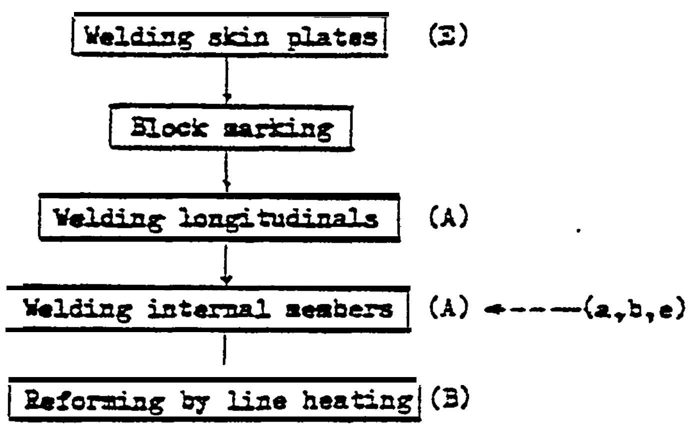
3) Excess treatment to be matched with the assembling method

Assembling method can be divided into the following two (2) categories. One is the egg-crate *method. The other is the* method of pre-welding longitudinal frame to the plates.

<u>Egg-crate method</u>



<u>Pre-welding longitudinals to the plate</u>



As shown in the above flows, the fabrication sequeaces (welding sequences) are different from each *other.* *This means* that the *shrinkage* by welding results in the different seqencs. Therefore in order to prevent gaps, it is necessary to allow the required excess at the conne— ction part of the skinpltes the internal members and the longitudinals.

In addition, the inter-relationship between the skin plates and the internal members should be reinforced.

There are four methods for distributing shrinkage taking into consideration the excess treatment method and the fabrication method as shown below.

Fabrication Method / Excess Treating Method	Egg-crate Method	Pre-welding Longitudinal
Undivided whole excess at the plate edge	For: skin plate internal members	For: skin plate internal members
Separately distributed excess	For: skin plate internal members	For: skin plate internal members

3.3 Establishment of a Standard for production practice and working practice considering the flow of information and data

The two (2) standards previously recommended are said to be fundamental functions and data which should be used by all organizations of the shipyard On the other hand, the third recommmdation is to establish the concrete standard practices at NASSCO, whic will define the goal and improve quality potestial.

To establish the standard practices for each shop, the role of each must be clearly reviewed in the production process flow, that is, the input and the output should be clear. The necessary data and information to obtain high accuracy in a shop should result from the output in its preceding phase.

As described before, workmanship at NASSCO is considered to be satisfactory. The problem is that the potentiality depends on personal experience since the practices are not written at this time. If the practice is written into the standard with some improvements, a uniform quality can be maintained by different personnel, therefore training new personnel becomes much easier.

1) production standard practice

Each shop has its own standard practice.

(1) Standard Practice for working drawing.

(2) Standard Practice for Mold Loft

1) Production practice standard (Continued)

(3) Standard Practice for Fabrication

(Marking, Burning, Bending)

(4) Standard practice for Assembly

(5) Standard Practice for Shipwright

(6) Standard practice for welding

Standards should not contrdict each other should be maintained or revised, if necessary, when a fabrication method is improved.

2) The contents Of the standards

The contents of be the standards are as follows:

(1) Check points

(2) Checking dimension

(3) Checking method

(4) Allowable tolarance

(5) Checking procedure for jigs and machinery

(6) Feedback and treatment

3) An example for assembly

(1) For a flat block (Skin plate)

- Plate arrangement (positioning, Match mark)
- Welding (Misalignment, Gap)
- Block marking (Diagonal length, width, straightness)
- Opening holes

3) An example for Assembly (Continued)

(2) For a curved shell block

- Supporting jig (Normality, Height)
- Plate arrangement (Jig position)
- Datan line for joint
- Block marking (Four edges Diagonal length)
- Opening holes

(3) For fitting

- Eliminating welding bend at the cross point of joints and internal structures
- Gas cutting (Gas notch, Roughness, Cheek line)
- Edge point of webs
- Edge point of frames
- Fitting angle, of webs agaiasrt the skin plate
- Fitting angle of frames against the skin plate
- Fitting collar plate
- Misalignment and gap at the cross point of internal members

(4) Grinding up

- Wrong bend
- Bead at temporary piece for fitting

3) An example for Assembly (Continued)

(5) **Reforming by like heating**

- Connecting part **at the edge of** block
- ***Burning*** tamperature
- Location

(6) Finished UP

Concerning the **above,** the actual examples from IHI shall be present(
in the next chapter.

4. INTRODUCTION OF IHI ACCURACY CONTROL SYSTEM

In order to clarify the procedure of Accuracy Control, the IHI Accuracy Control System is introduced as one of the actual examples. The following flow chart indicates a total scope of the IHI Accuracy Control System (see Fig. 2).

As shows in the flow the following items are clearly defined.

(1) Working flow from Basic Design through production process.

(2) Connection between working flow and organization.

(3) Location and role of the standard

SPAIS ..... The Shipbuilding Process And Inspeciton Standard

Excess Standard.

Working Practice Standard

(4) Accuracy Control data for the actual ship

- Blocking (Block division)
- Excess
- Fabricacion sequence
- Checking proced-
- Allowable tolerance
- Base line (March mark)

These data are defined and administared by production planning uader the authorization of the Accuracy Control Committee.

(5) Where and how are those information recorded and distributed?

(6) Feedback/Amendment flow

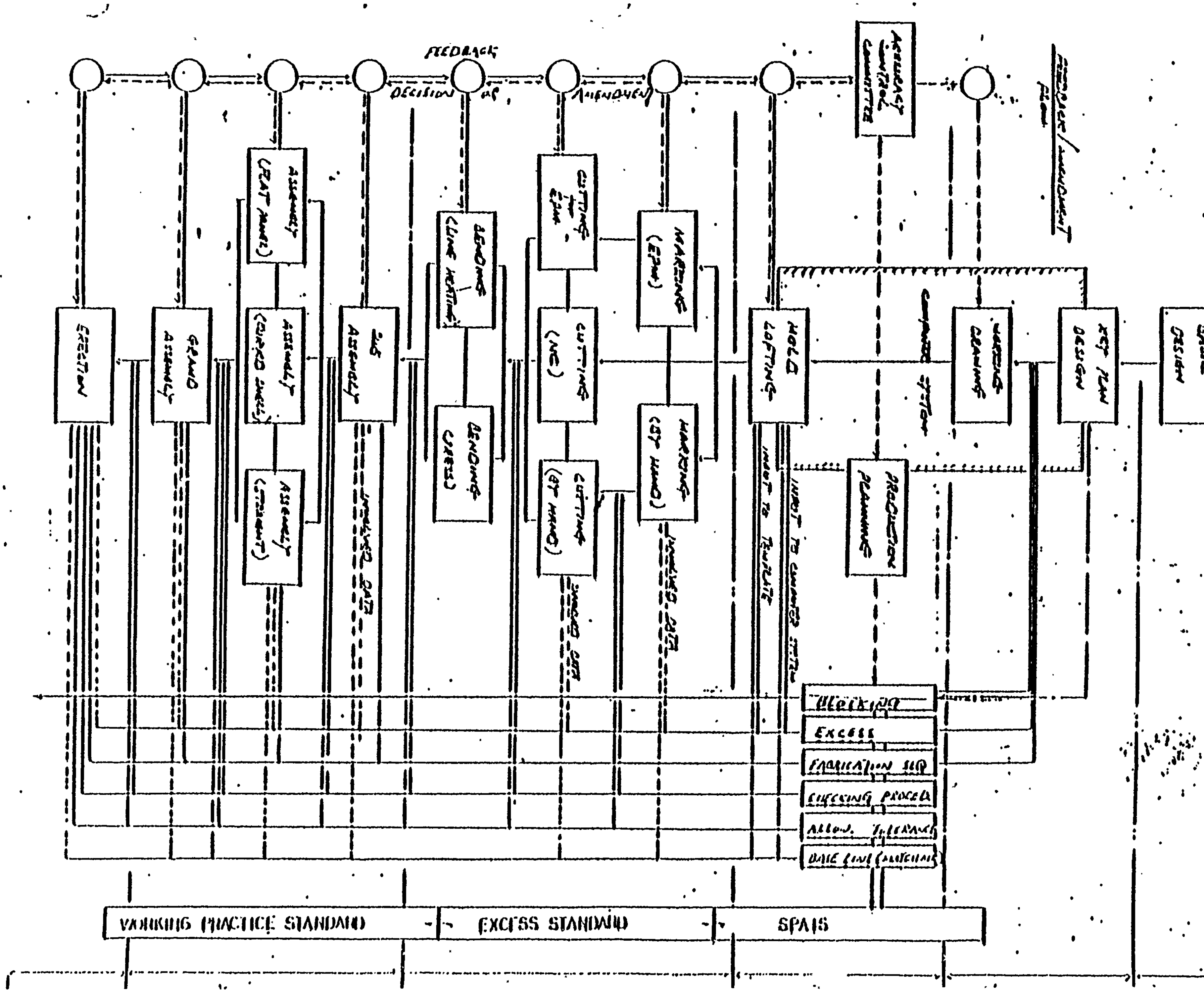


Fig. 2

INFORMATION FLOW OF THE ACCURACY CONTROL SYSTEM

A detailed description on the IHI system is presented in the follow documents:

(1) "IHI Accuracy Control Systen"

The following are referenced in the above document.

1) Accuracy Control - Check points, Checking Dimension, Check Method based on Fabrication sequence for Future - 32 bulke prepared by IHI.

2) Accuracy Control Check Sheet for Future - 32 Bulkers - prepared by IHI.

3) Accuracy Control - The Scheme of the Added Materials and Phase for Finishing up for the Future - 32 Bulkers at IHI AIOI-Shipyard, prepared by IHI.

4) Standards and Tolerances for Maintaining High Accuracy at AIOI-Shipyard, prepared by IHI.

* Hull Block construction in Kure Shipyard of IHI.

* Base Line effective for maintaining high accuracy included in the output through engineering and lofting.

5. THE EXPECTED SCHEDULE FOR THE 2ND SURVEY AND IMPLEMENTATION AT NASSCO

The following is the proposed schedule for implementation of Accuracy Control and the 2nd survey at NASSCO.

* 1st week - 2nd week

  ~~?l=atioxl of IHI's report on the 1st Survey.

* 2nd week - 3rd week

  Discussion and reconciliation of recommendation from IHI.

* 4th week - 6th week

  Detailed survey at each shop to document (learn) the A.C. activities.

  it appears to be. easier to start from the actual activities than preceded with the study on the basic standard. Through the three-weeks study, NASSCO can draft up its own basic standards referring to IHI's standard.

AN EXTRACT OF THE SPAIS OF IHI
The Shipbuilding Process And Inspection Standard)

QUALITY CONTROL STANDARDD

(Hull part)

JUNE, 1979

ishikawjima-Harima
Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCT034

QUALITY CONTROL STANDARD

(HULL PART)

I.H.I. KURE SHIPYARD
QUALITY CONTROL DEPARTMENT

1 MAR. 31. 1977

INTRODUCTION

All newbuilding I.H.I Kure shall be constructed and inspected in accordance with "Quality Control stadard".

It iS the intent of this standard to supplement "shipbuilding Process and Inspection Standard" which is established by I.H.I.

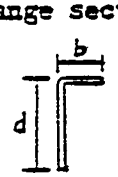
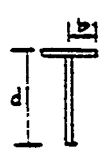
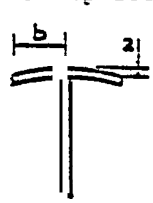
INDEX

Gas Cutting (Notch)

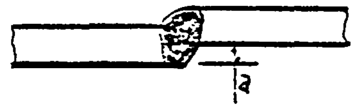
limit?

Item	Allowable limit	3emarirs.
1. Ftes edge		
1) Upper edge of sheer; Strake.	Indentation -0	In case where it is necessary tc smoothly finished by grinder it to be welded up.
2) Strength deck between 0.6L Ж and free edge of opening of shell plate.		
3) Main longitudinal strength member.		
4) Longitudinal and transverse strength members.	Indentation ≤ 1	
5) Others	Indentation S 3	
2. Weld groove		
1) Shell plate and upperdeck between 0.6 L Ж.	Indentation S 2	Notch is to be repaired by grin or gouging.
2) Others	Indentation53	

Fabrication

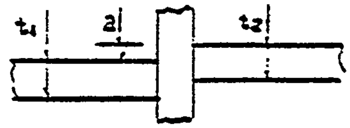
Item	Allowable limit	Remarks
1. Size of Member		
1) General members, compared with correct sizes.	+ 5.0	
2) Especially for the depth of floor and girder of double bottom compared with correct sizes.	+ 4.0	
3) Breadth of face bar, compared with correct size.	-3.0 ~ +4.0	
2. Size		
1) Flange section 	b : ± 5.0 d : ± 5.0 (d : ± 3.0)	The bracketed ones show the case where strength is especially required. (e.g. longitudinal members, etc.)
2) Built-up section 	b: nominal. breadth -2 d: nominal depth ± 2	
3. Angle		
1) Flange section 	$\frac{\pm 4.5}{100}$	compared with template
2) Built-up section 	$a \leqq \pm (3 + \frac{b}{100})$	

Misalignment in butt joint

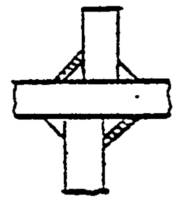


Item	Allowable limit	Remarks
1. skin plates (Bottom shell., side shell, & deck plate) and longitudinal strength members	a ≤ 0.15 t (· max = 3.0)	1. When 'a' exceeds that allow limit, the butt shall be rea [illegible]
2. Bulkhead plates and insterior members (including face plate)	a ≤ 0.2 t (a max = 3.0)	2. When 'a' exceed the allowab limit, the reinforcement by welding shall be done or th plate shall be realigned af mutual discussion among bui buyer and classification so

Misalignment in fillet connections

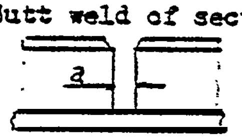
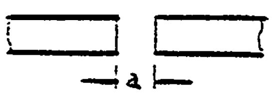
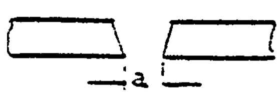


Where $t_1 \geq t_2$

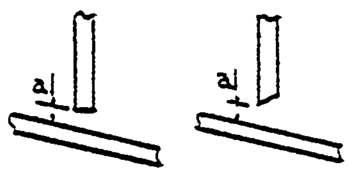
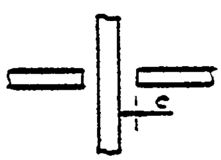
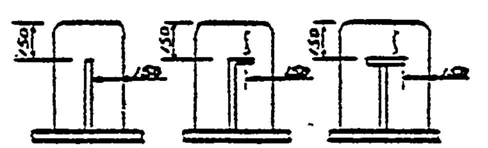
Item	Allowable limit	Remarks
1. For main structures	$a \leq 1/3\ t2$ In case 1) $1/2 t_2 \geq a > 1/3 t_2$ 2) $a > 1/2 t_2$	When 'a' exceeds the allowable limit, following treatment shall be applied. 1) Weld leg length shall be increased by 10 %. 2) The member shall be re-aligned. 
2. For others	$a \leq 1/2\ t2$ In case 1) $a > 1/2\ t_2$	The member shall be realigned.or fitted with backing strip.

Ishikawajima-Harima Heavy Industries Co., Ltd.

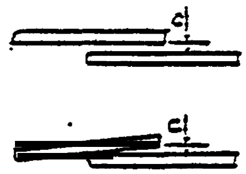
Gap between butt weld edge

Item	Allowable limit	Remarks
1. Butt weld plates 	$a \leq 5$	When 'a' exceeds the allowable l[imit] the edges shall be treated as fo[llows]
	In case 1) $5 < a \leq 16$ (When PL. thick ≥ 10) ▲ $5 < a \leq 10$ (When PL. thick < 10)	1) The edge shall be built up weldilng with a backing strip, and then back welding shall be done after removing the backing strip and after back chipping. 
	2) $25 \geq a > 16$ (When PL. thick ≥ 10) ▲ $16 \geq a > 10$ (When PL. thick < 10)	2-a) When the renewal of a longi[tudinal] member is necessary, the sc[ope of] the renewal shall be dicided [case] by case, with the agreement [of] the buyer and the classific[ation] society. For the other members, the [insert] of at least 300mm width sha[ll be] renewed. 2-b) If 2-a is not applicable, t[he] edge shall be built up by welding, and then the butt shall be welded. 
	3) $a > 25$ (When PL. thick > 10) ▲ $a > 16$ (When PL. thick < 10)	3) The members shall be partiall[y] renewed in the same way as sp[ecified] in above paragraph 2-a.
2. Butt weld of sections 	$a \leq 5$	When a exceeds the allowable lim[it] the gap shall be treated in the [same] way as the butt weld plates.
3. CES welding 	$17 \leq a \leq 40$ In case 1) $40 < a \leq 40 + t$ 2) $a > 40 + t$	When a exceeds 40mm, the gap sha[ll be] treated as follows. 1) The edge shall be built up by [weld]ing. 2) The plate shall be partially renewed.
4. Electro gas welding 	$10 \leq a \leq 30$ Incase 1) $30 < a \leq 30 + t$ 2) $a > 30 + t$	[illegible] 1) The edge shall be built up by welding 2) The plate sh all be partially

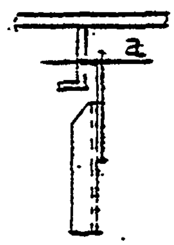
Gap between members in T connection and penetrations

1. T connection  	1) 3 < a ≤ 5 2) 5 < a ≤ 16 (When PL.thick ≥ 10) △ 5 < a ≤ 12 3) a > 16 (when PL.thick ≥ 10) △ a > 12 (when PL.thick < 10)	1) 2) 3)
2. Members penetrating through bulkhead plates  	C or C1 ≤ 3 In case 1) 3 < C or C1 ≤ 7 2) C or C1 > 7	When 'C' or 'C1' exceeds the allowable limit, the slot shall be treated as follows. 1) 2)  If the penetrating members are designed with a lapped collar plate, the collar plate shall be replaced.

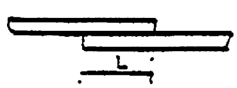
Gap of laps between members

Item	Allowable limit	Remarks
3. Lap weld 	$c \leq 3$ In case 1) $3 < c \leq 5$ 2) $5 < c$	When 'c' exceeds the allowab limit, following treatment s be applied. 1) Weld leg length shall be increased by 'c' mm. 2) The member shall be real

Gap Of laps between beams & frames

Item	Allowable limit	Remarks
	$a \leq 3$	When 'a' exceeds the allowab limit, the members shall be realigned.

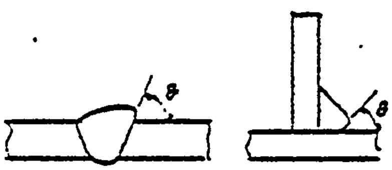
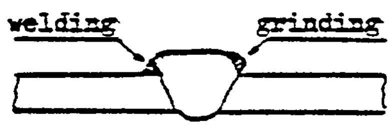
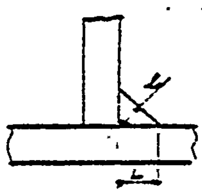
Breadth of lap joints

Item	Allowable limit	Remarks
Breadth of lap 	L=rule requirement In case 1) Shortage of lap $\leq t$ 2) Shortage of lap $> t$	When 'L' is less than the ru requirement, the joint shall treated as follows. 1) The edge shall be built welding where the lap is 2) The plate in shortage of shall be partially renew or if applicable, the jo may be modified to a butt joint.

Under-cut in Welding

Item	Allowable limit	Remarks
1. For butt welds		
a) For main structures within 0.6L ⊠ (skin plate, longitudinal member and principal transverse supporting members)	max depth: 0.5mm (length of more than 90mm)	When under-cut exceeds the allowable limit, the under-cut shall be filled up by weldings. However, the filled up welding shall not be ground off.
b) For other members	max depth: 0.8mm	
2. For fillet welds	max depth: 0.8mm	

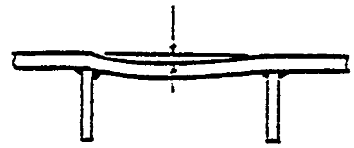
Shape of welding bead

Item	Allowable limit	Remarks
1. Height of reinforcement	not defined	
2. Breadth of bead	not defined	
3. Flank angle 	$\theta \leq 90^\circ$	In case where θ is over 90°, it is to be repaired by grinding or welding to make $\theta \leq 90^\circ$. 
4. Leg length 	L : leg length ℓ : throat depth ≧ 0.9L ≧ 0.9ℓ	In case where it is over tolerance limits, weld up over it.

Other welding item

Item	Allowable limit	Remarks
2. Short bead 1) Higher tensile steel (50 kg/mm^2 class) 2) Mild steel	$\geq$ 50 mm not defined	In case where short bead is used unavoidablly, preheating is neces at 100 $\pm$ 25^{o}C. When short bead is made arroneous remove the bead by grinding, and weld over 50mm after checking roo crack or heel crack.
2. Arc strike Higher tensile steel (50 kg/mm^2 class) and grade E steel of mild steel	prohibit arc-strike	In case where arc-strike is made erroneously, one of the following repair method is applied. 1) Weld over 50mm bead on the arc-strike. 2) Remove the hardened zone by grinding. 3) Apply post heating at 350 - 65(

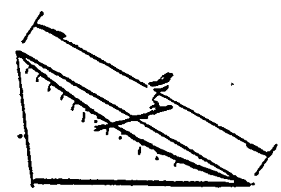
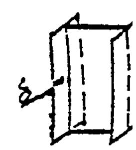
Deformation



Division	Item	Allowable limit mm
Shell plate	Parallel part side shell	6
	Parallel part bottom shell	6
	Fore and aft part	7
Double bottom tank top plate		6
Bulkhead	Longitudinal bulk-head	7 (t ≤ 3
	[illegible]	8 (t [illegible]
	Transverse bulkhead (Swash bulkhead)	8
Strength deck	Parallel part (between 0.6 L [illegible])	6
	Fore and aft part	8
	Covered part	9
Second deck	Bare part	8
	covered part	9
Fore-castle deck Poop deck	Bare part	6
	Covered part	9
Super-structure deck	Bare part	6
	Covered part	9
House wall	Outside well	6
	Inside Wall	6
	Covered part	9
Web of girder and trans		7
Floor & girder in double bottom tank		7

Distorsion & Straightness (Curvature)

limit of angle?

Item	Allowable limit	Remarks
1. Distorsion of beams, frames or stiffeners (per L Span)	1) $\delta \leq 7$ 2) $\delta \leq (5 + \frac{2\ell}{1000})$ 3) $\delta \leq 12$	1) When $\ell \leq 1000$ 2) When $1000 < \ell < 3500$ 3) When $\ell \geq 3500$
2. Distorsion of girder and long. (per 1 span)	1) $\delta \leq 5$ 2) $\delta \leq (3 + \frac{2\ell}{1000})$ 3) $\delta \leq 10$	1) When $\ell \leq 1000$ 2) When $1000 < \ell < 3500$ 3) When $\ell \geq 3500$
3. Straightness in the plan of flange and web	± 25 (per 10m length)	
4. Tr. BKT & stiff. with web (when free edge)	$\delta = \ell \times \frac{8}{1000}$ (max. 12)	
5. Pillar (between deck)	1) $\delta = 6$ 2) $\delta = \ell \times \frac{1.2}{1000}$ (max. 12)	1) When $\ell \leq 5.000$ 2) When $\ell > 5.000$ 

Line heating method

Kind of steel	Max. permissible temperature	Max. temperature for commencing w. cooling	Remarks
Mild steel	900 °C	850 °C	Air cooling and water cooling
H. Z'. steel	900 °C		Air cooling
	900 °C	500 °C	Water cooling
	650 °C	650 °C	Water cooling

MANAGEMENT FOR HULL CONSTRUCTION MATERIALS DEFECT

("F" series ship)

JUNE, 1979

Ishikawajima-Harima

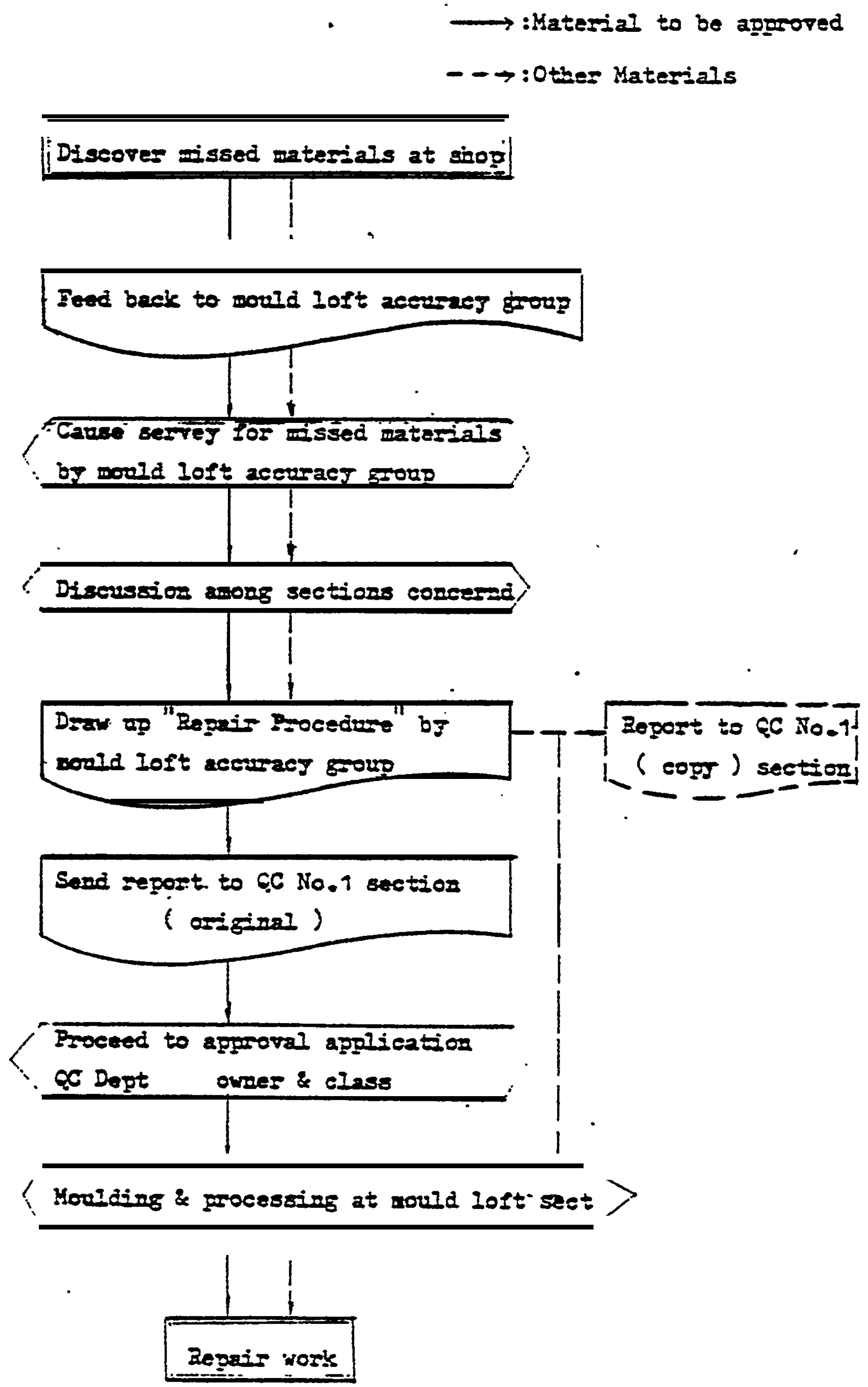
Heavy Industries Co., Ltd.

TOKYO JAPAN

No. KCT035

CONTENTS

Management Flow chart for Miss Manufactured Materials



Management for Hull Construction Materials Defects

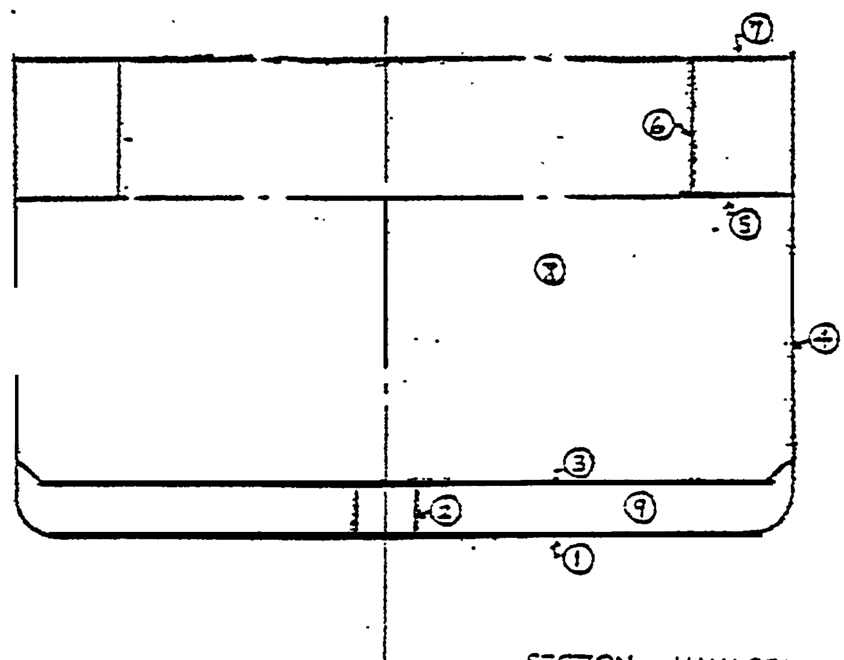
("F" Series)

1) As for repair of defect, The area necessary for approva[l] by the owner and classification society will be shown in the following sketch. (Item ① ~ ⑨)

2) The defective materials of the area except mentioned ab[ove] should be repaired in the yard side according to " Repa[ir] procedure for hull construction materials "

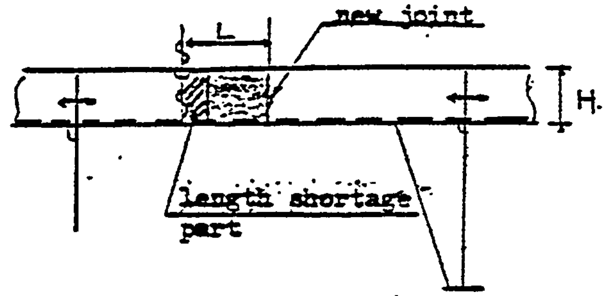
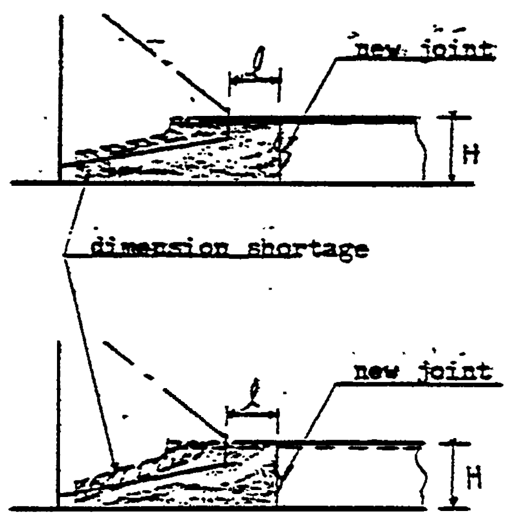
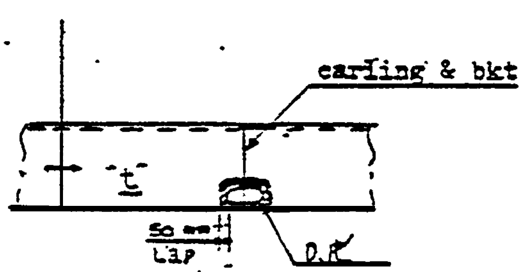
The area to be repaired after approval

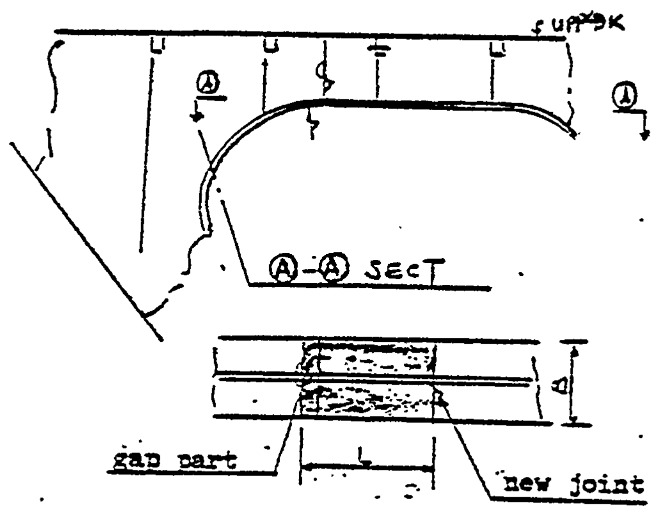
① --- BOTTOM SHELL & BILGE SHELL
② --- L.I W.T GIRDER
③ --- DOUBLE BOTTOM
④ --- SIDE SHELL
⑤ --- RETRACTABLE TWEEN DECK
⑥ --- L.I HATCH SIDE GIRDER
⑦ --- UPPER DECK
⑧ --- TRANSVERS BHD
⑨ --- W.T FLOOR

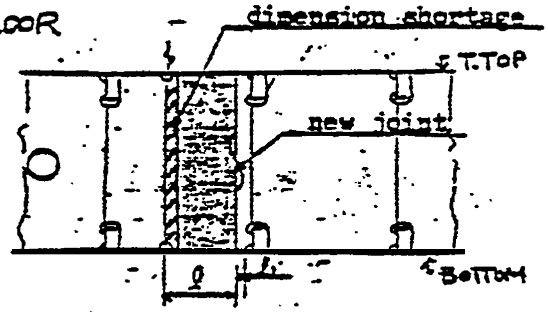
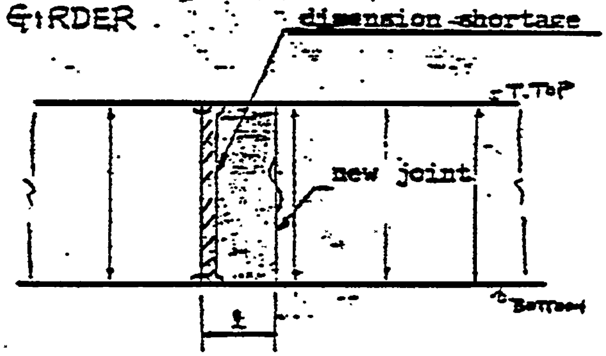
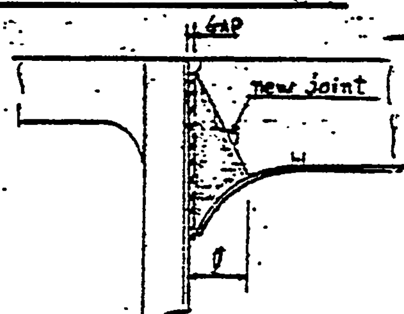
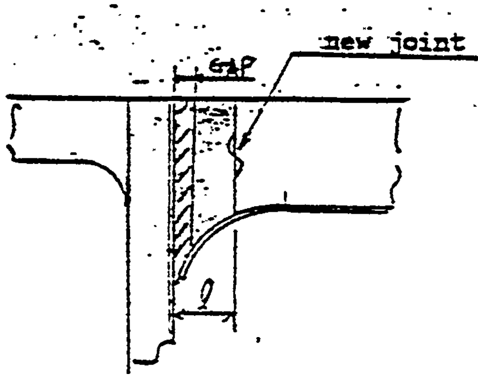


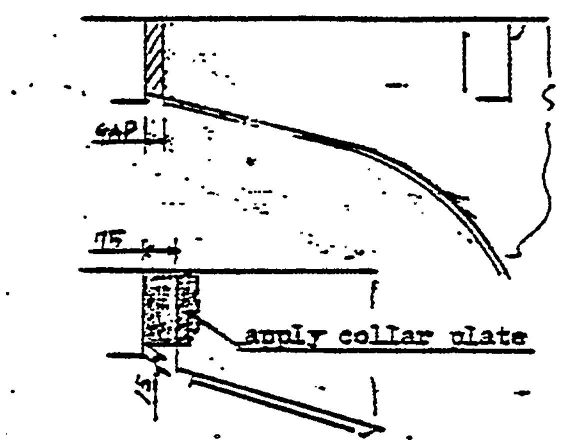
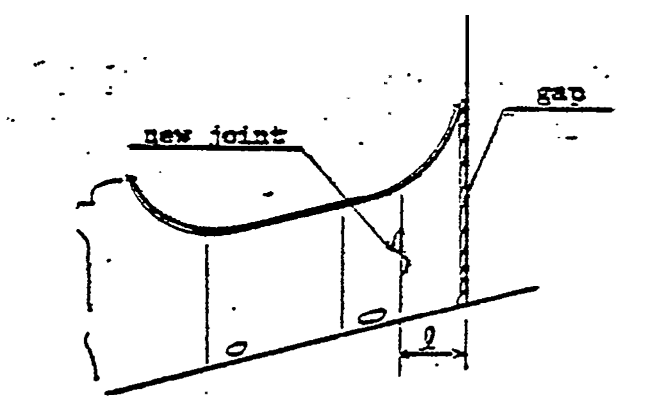
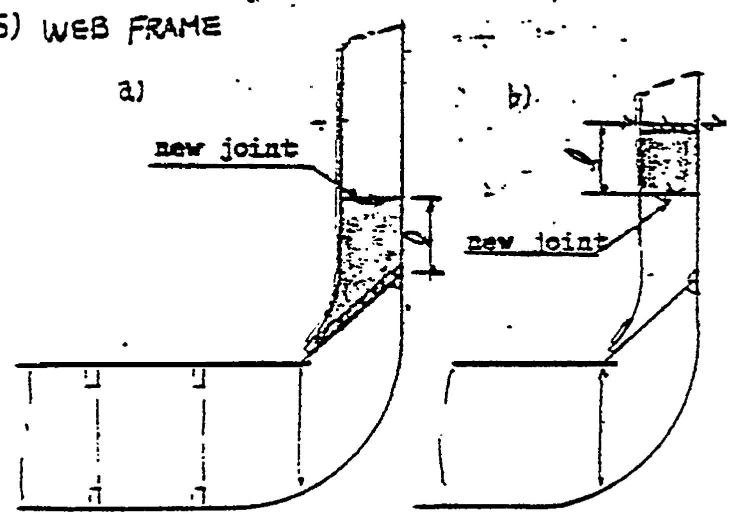
SECTION MANAGER OF
No.1 QUALITY CONTROL SECTIO[N]

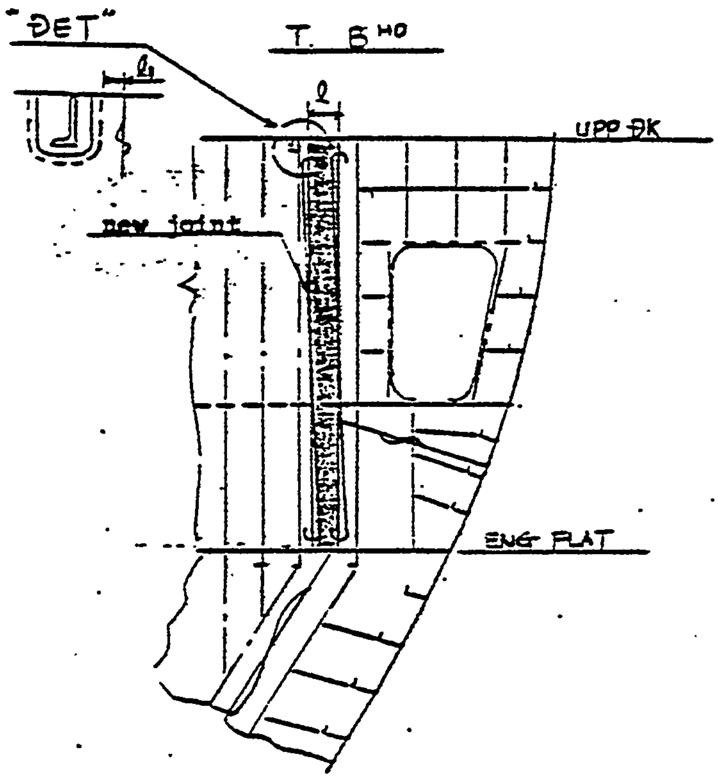
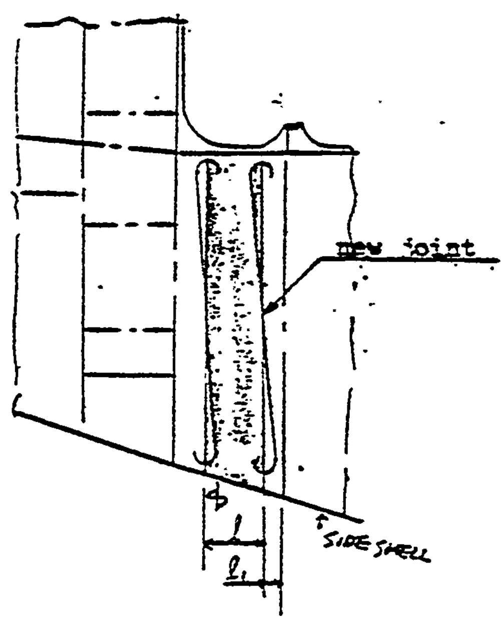
Repair procedure for hull construction materials

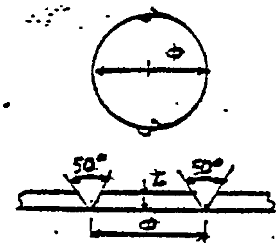
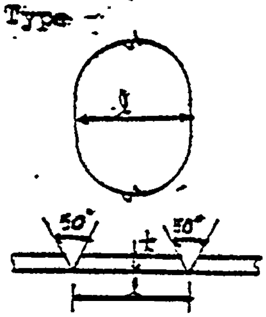
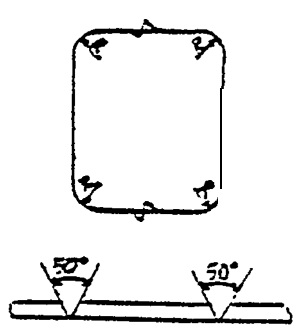
Division	Item	Remarks
ANGLE STIFFNER	(1) In case of length shortage 	a) In case of H ≦ 300 L = 600 b) In case of H > 300 L = 2H
	(2) In case of lap shortage & poor end part 	l = 150 l = 150
	(3) In case of materials contact with drain hole 	a) thickness of doubler plate equal to mother material "t" b) doubler plate is to be fitted on skeleton side

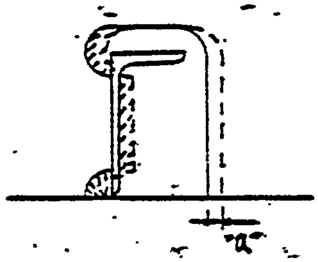
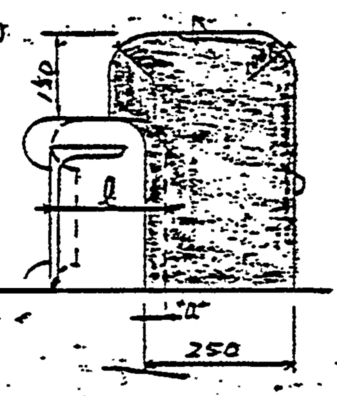
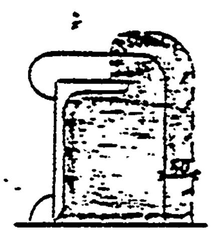
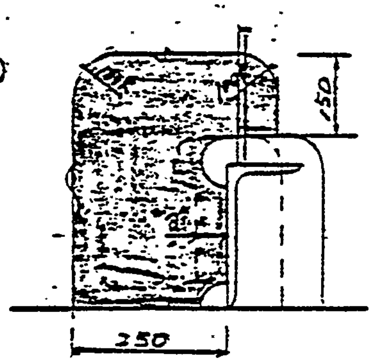
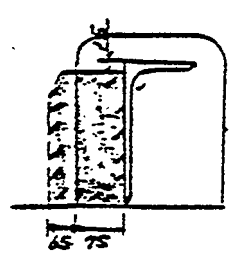
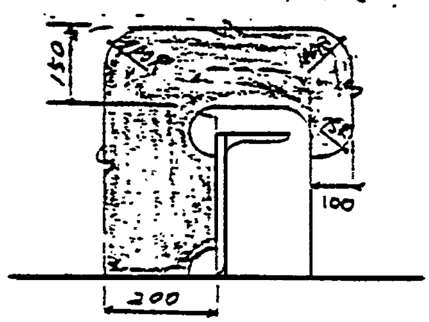
Division	Item	Remarks
BUILT-UP LONG	(1) In case of length shortage	follow to " angle stiffner"
	(2) In case of lap shortage & poor end part	- do. -
	(3) In case of materials contact with drain hole	- do. -
FACE PLATE		a) In case of $B \leq 200$ $L = 3B$ b) In case of $200 < B \leq 300$ $L = 600$ c) In case of $B > 300$ $L = 2B$ (max. 1.000)

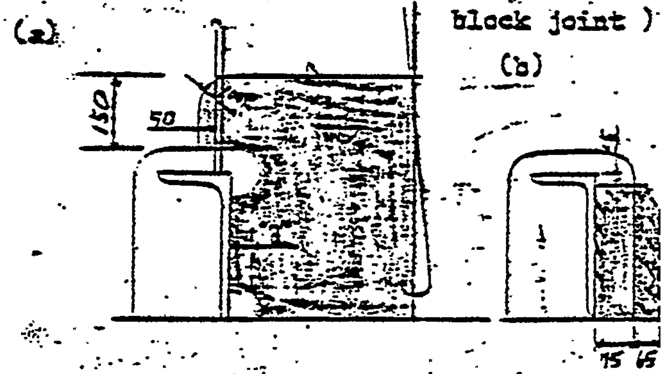
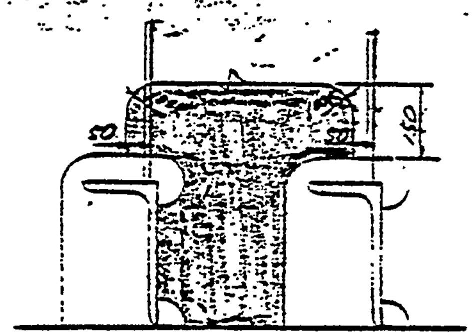
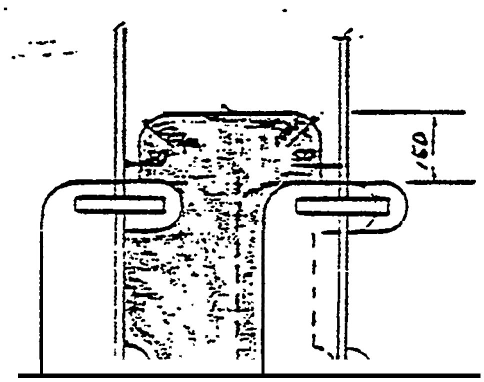
Division	Item	Remarks
FLOOR GIRDER WEB PANT.STR etc	(1) FLOOR  (2) GIRDER  (3) WEB a) In case of small gap  b) In case of big gap 	$l \geq 300$ (l_1 = MIN 50) $l = 450$ a). $l = 300$ b) $l = 300$

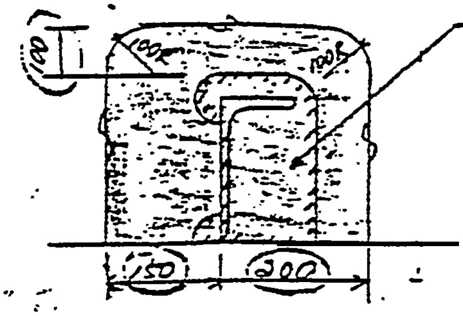
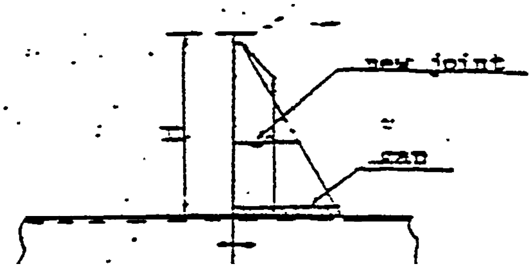
Division	Item	Remarks
	c) Gap in way of stiffner end	
		
	(4) PANT. STR (TRANS & GIRDER)	
		$l = 300$
	(5) WEB FRAME	
		a) $l = 300$ b) $450 \leq l < 60$

Division	Item	Remarks
T. B^HD & FLAT		$l = 300$ $(l_1 = \text{MIN } 50)$
	FLAT 	$l = 300$ $(l_1 = \text{MIN } 75)$

Divisio:	Item	Remarks
HOLE	(1) Circle Type 	Important membe a) when, t ≦ 13 min φ = 200 b) when, t > 13 φ = 15 x t max = 450mm Other member a) when, t ≦ 16 min φ = 200 b) when, t > 16 φ = 12 x t
	(2) Oval Type 	- do.-
	(3) Square Type 	for temporary (min "R" = 15

Division	Item	Remarks
SLOT	(1) "A" type (slot : miss position) a) In case of "a" ≤ 50  b) In case of "a" > 50 (1)  (2) 	slot : leave as it is. oblique lined part to be gas cutted. (1) slot size when, l > 210 (2) slot size when, l ≤ 210 apply collar plate
	(2) "B" type (slot : miss position) (a)  (b) 	(a) when, "a" > 75 (b) when, "a" ≤ 75 apply collar plate
	(3) "C" type (slot : over size in height) 	

Division	m	Remarks
SLOT	4) "D" type (slot : short size in height)	apply collar p
	5) "E" type (slot : miss position in way of block joint) 	(a) when, "a" > (b) when, "a" ≤ apply colla
	6) "F" type (miss position of adjoined slot) 	
	7) "G" type (miss position of adjoined slot) 	

Division	Item	Remarks
SLOT	(8) "H" type (slot : miss open) 	
BKT & FB		(a) when. H ≤ 550mm renew (b) when. H > 550mm partial renew (300mm)

IHI ACCURACY CONTROL SYSTEM

JUNE, 1979

Ishikawajima-Harima
Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. NO. KCT036

CONTENTS

1.0 Preface

Activity for keeping high accuracy of ship's hull as a part of quality control has been performed at every shipyard of IHI This activity is promoted by Production Control Department under the support of whole organization of the shipyard from Engineering Department to Hull Construction Department.

As described in the following chapters, this activity is a systematic and integrated approach to achieve the aim given to the shipyard. i.e. how to construct a ship in safe and highly productive manner.

The terminology of "Accuracy Control" may be new word but its idea shall be understood through this brief paper. Accuracy control can be said one of the concentrated know-how of IHI's shipbuilding technology accomplished through the Long experience still being refined every day.

2.0 IHI Accuracy control System

Though final inspection of hull Structure is reminded to be important in the meaning of gurantee of ship's quality, IHI considers that quality control through the production process must be more important.

IHI Accuracy Control is a system to be supported by all organizations of the shipyard from Engineering, Mold Lofting, Marking.

a ship in safe, in high quality, in high productivity and eventually in low cost. In that meaning, the terminology of "Accurac Control" is distinguished from "Quality Control" or "Quality Assurance". ?

2.1 Basic Philosophy in Promoting Accuracy Control at IHI

Even though there might be many ways of accuracy control, IHI considers that the biggest theme in hull construction is to keep high accuracy of the shape of hull units at the erection stage. In other words, the theme is to minimize the works at erection with the effort by the preceding phases such as assembly, sub-assembly, fabrication and engineering, including mold lofting. Because at erection stage, various kinds of hard works shall be caused by an inaccurately constructed unit such as:

- Too many gas cutting to adjust erection joints.
- Welding with a backing strip to fill up a too big gap at a joint.
- Cutting off previously welded parts and rewelding to set right the connecting parts at a joint.

2.1 Basic Philosophy in Promoting Accuracy Control at IHI (Corkaued)

o Too much gas cutting for adjustment to erection joints.

0 Welding withh a backing strip to fill an oversized gap at a joint.

o Cutting off previosly welded parts and rewelding to align the connecting parts at a joint.

ALmost all of this work needs to be performed on high scaffolding where working conditions are neither safe nor conveninent.

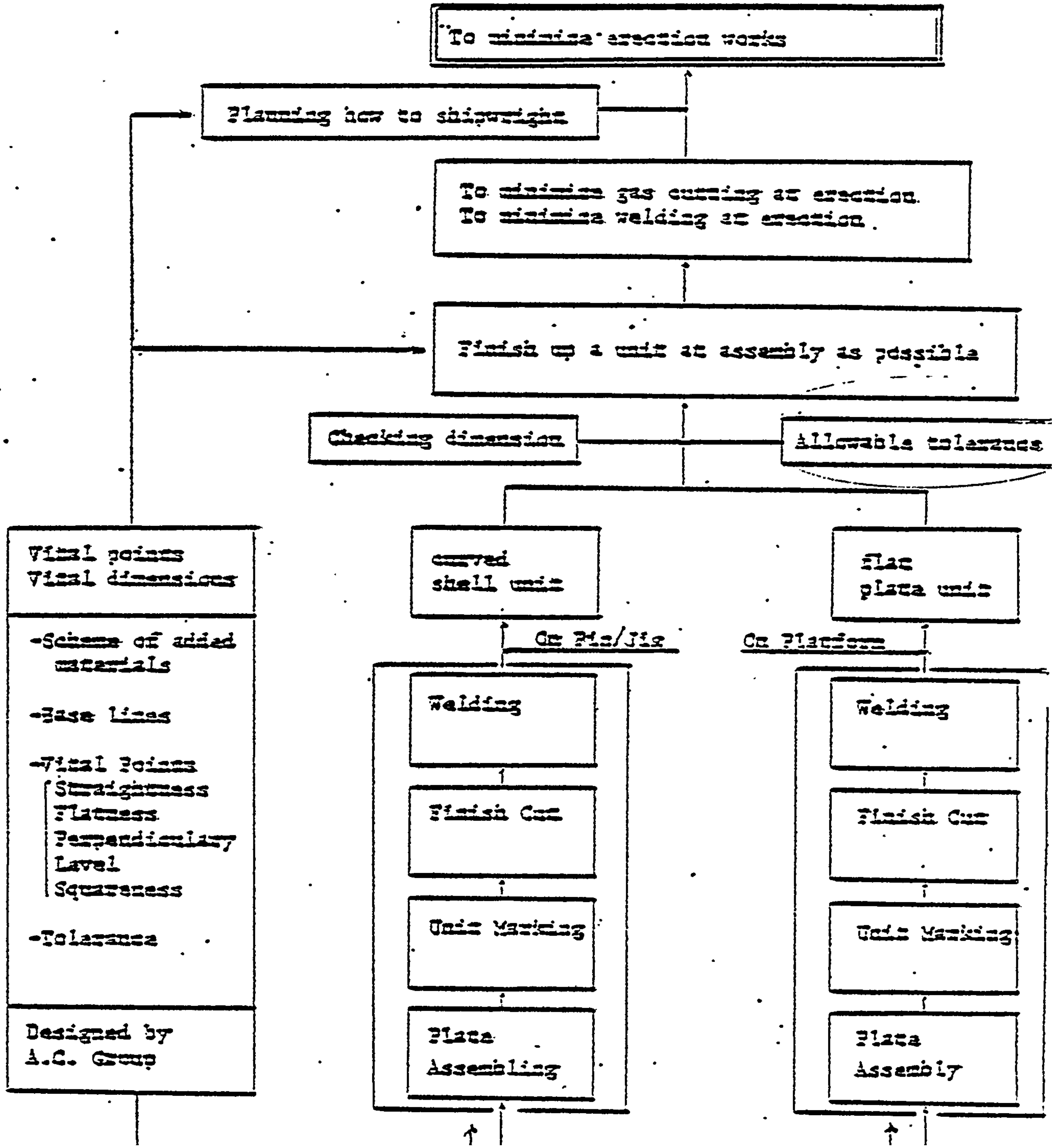
It must be recognized that accuracy in erection is a result of accuracy in the preceding steps to erection such as marking, cutting, bending, fitting and welding.

Before introducing the actual method used in Future-32 Bulkers, a brief explanation on the concept of IHI Accuracy Control is presented in the following (2) flow charts:

Flow chart - 1: Concept of Accuracy Control in IHI

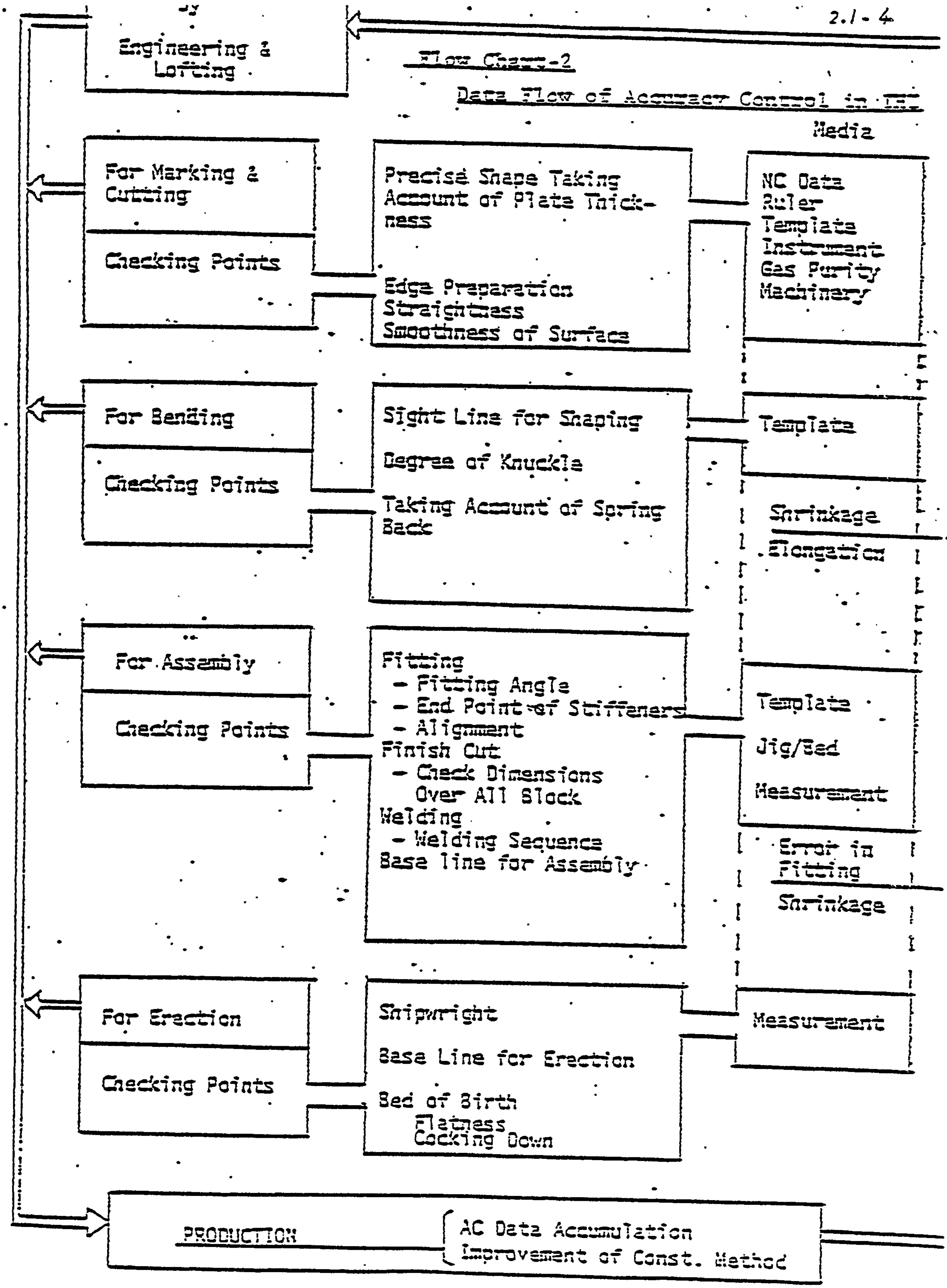
Flow Chart - 2: Data Flow of Accuracy Control in IHI

Flow Chart - 1 Concept of Accuracy Control in IHI



Flow Chart-2

Data Flow of Accuracy Control in IHI

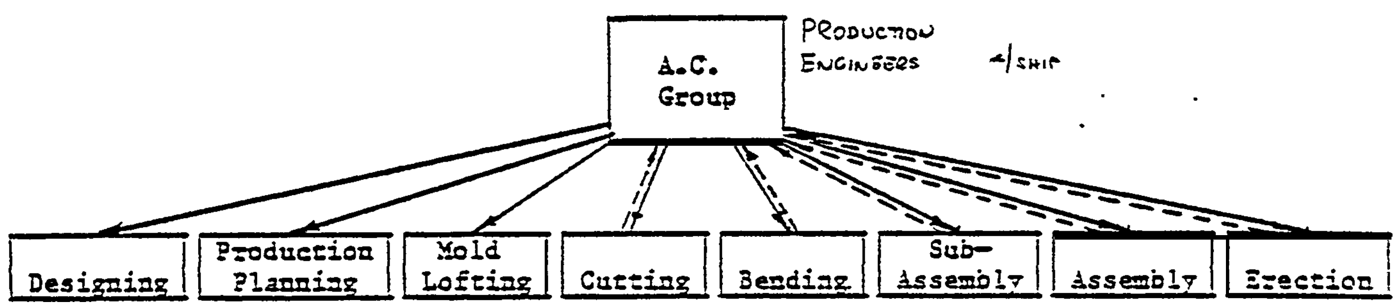


2.2 Accuracy Control Procedures for IHI Future-32 Bulkers

As described in 2.0 of this paper, the activities of Accuracy Control are started before the development of a working drawing. This procedure has not only been used for Future-32 Bulkers but is also applicable to other ships.

IHI's procedures follow a cycle, called the ZD cycle (Zero Defect Cycle), of "Plan Do - See - Action" l This procedure attaches special importance to the elements of 'See' and 'Action'. They are viraL to the success of work and are linked to the next stages of the plan.

The actual activities at IHI AIOH-Shipyard are presented from design to production as follows : A specialized group called the A.C. Group, four hull production engineers per building berth/dock are assigned. They direct all Accuracy Control activities in every process, with the support of every work shop. The following figure is a data flow chart designed by the A.C. Group.



2.2 Accuracy Control. Procedures for IHI Future-32 Bulkers (Continued)

1) A.C. Engineer attendance at the preliminary design phase

After basic design, Accuracy Control activity commences. At that time, basic drawings are issued; that is, LINES (not fair MIDSHIP SECTION, CONSTRUCTION PROFILE, GENERAL ARRANGEMENT and MACHINERY ARRANGEMENT.

The A.C. Group participates in dsigning the Block Division an Erection Sequences. An indepth study from many aspects is conducted on the Cargo Hold Section because it is the most essent portion of hull coustruction from the viewpoint of concentrate work load. In addition, the cargo hold section is the startin point far the accuracy control of the curved part. The fabric tion method of cargo hold units and curved units, shipwright welding methods, and vital points for maintaining high accurac are studied. Along with the basic planning for hull productior preliminary drawings on Shell Expansion, Upper Deck Plan, Inne Bottom Plan, Longitude Bulkhead profile and Section Drawing ar developed. These drawings are used for detailing the fabricat method and Accuracy Control Planning. Next the working drawin are developed.

During this procsss, the following data is generated by A.C. Group :

2.2 Accuracy Control Procedures for IHI Future-32 Bulkers (Continued)

The scheme for the excess and the phase for completion

This scheme is designed to take into account the following fundamendal functions:

* Vital points and vital dimenions to maintain high accuracy.
* Fabricating sequence and fabricating method for a uuit.
* Erection sequence of units.
* Welding method.
* Consideration for shrinkage.

In this drawing, the following information is involved:

* Dimensions of excess materials.
* The phase for completion.
* Welding method (automatic welding to be adopted)

An actual example is provided in the attached paper, "The Scheme of the Added Materials and the phase for Completion for the Future-32 Bulkers at IHI AIOI-Shipyard".

o Check points, checking dimension, checking method at Sub-assembly, Assembly and Erection.

o Instructions for shipwright erection.

2.2 Accuracy Control Procedures for IHI Future-32 Bulkers (Continued)

- o Vital points at the Fabrication phase (Marking, Gas Cutting and Sub-Assembly) and Base Lines to be gener from the Mold Loft.

The three documents listed above are designed to show concrete methods in promoting the Accuracy ControL activities in the ac phases of hull construction. The actual example for these is sented in the attached paper "Accuracy Control - Check Potie, Checking Dimension, Checking Method Based on Fabrication Seque for Future-32 Bulkers".

It should be noted that A.C. planning precedes commencement of working drawings, that is, this planning is a guidance to indi the actual fabricating method for the ship's bull on the worki drawings. In addition, through the Planning, discrepancies ar forecast and allowance for them is prepared.

2) Accuracy Control Activities in Production Planning and Construction Process

In this phase, the actual measurement is performed in accordance with the plan discussion in previous paragraph.

The Accuracy Control Group has designed a measuring sheet with certain points, such as, checking methods, responsible personnel and frequency of measurement. The actual form is provided in the attachment entitled "Accuracy Control Check Sheet for Future-32 Bulkers".

The actual measuring instruments used, Such as scale, wire, transit, plummet and special jigs are to be used for specific parts which are not easily measured by ordinary instruments.

IHI has a standard and tolerance table for maintaining high accuracy. It was developed as the result of IHI's long experience in this area. The values in the table are generally more strict than that required by ship's owners and classification agency. This is IHI's target at this moment.

With the combined use of the tolerance and check sheet, actual measurement and checking is Conducted.

The actual tolerances at IHI are provided in the attached paper entitled "Standard and Tolerances for Maintaining High Accuracy at IHI AIOI Shipyard".

3) Analyzing Measured Data

Measured data during the production process is gathered by the Accuracy Control Group and analyzed. As a result of the analys suitable action is taken by A.C. Engineer as follows:

o Continue more detailed investigation.

o Review the fabrication method.

o Investigate instruments.

o Investigate the foundation, such as platform at Assembly or cribbing at Erection.

o Coordinate the scheme of hand effort.

a Change dimension of excess materials (feedback to working drawing).

Dailly controL of workers is mainly performed by tolerance contr that is by checking to see whether errors are within the allowa tolerances. However, for improvement it is not sufficient to check only by the tolerance control method to ensure that all measured data are within the tolerance levels. The characteristics Of and tendency towards errors must be clearly identified, so that a statistical metho can be adopted to analyse measured data at IHI. Since the theory of statistics is weLl known, the applied method is briefly described here.

Where: $\bar{X}$: Mean Value

N : Total number of data

X_i : Data value (error)

N_i : Data number for value X_i

a) Generally Mean Value is significant only when the data is sampled at random. If data is gathered from a limited range, and it does not present source data realistically.

b) Usually Mean Value of errors are planned zero (0). So if the actual Mean Value is different from the one planned, it could signify that thw Mean Value should be re-planned or the fabrication method should be changed. Refer to the following examples.

c) Examples

Ex 1: Take a premise that the Longitudinal BHD under a Tank Top is finally cut at cutting phase with some margin for shrinkage, and Mean Value of measured data after welding at Sub-Assembly presents the shortage comparing with the planned value (zero).

(Judgment)

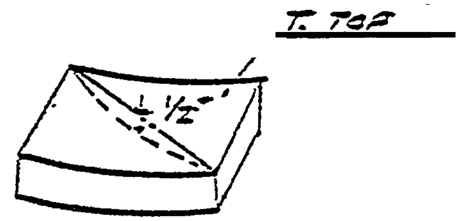
Check Gas Kerf compensation. Then, if Gas Kerf compensation is good enough, margin for shrinkage was too short.

3) Analyzing Measured Data (Continued)

(Action)

Add the absolute value of the Mean Value to the previous planned margin.

Ex 2: Mean Value of deformation at Tank Top plate was detected by 1/2" at the center of the plate.



(Judgement)

Check the level at the platform on which the uni were constructed.

(Action)

If the Levd at the platform is good enough, imp vement of fabrication method, such as, "inverse strain" shall be considered.

(3-2) Standard Deviation:

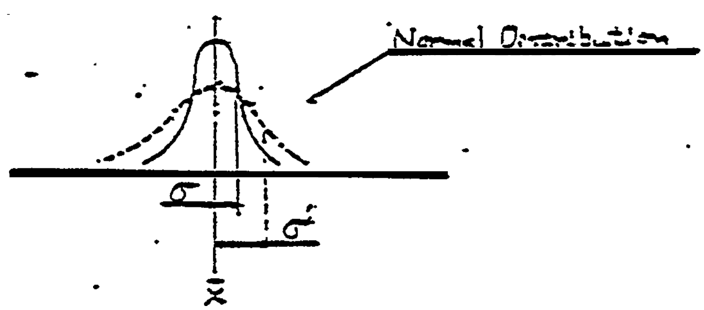
$$\sigma = \sqrt{\frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + \text{———} + (X_i - \bar{X})^2}{N - 1}}$$

where
σ : Standard deviation
$\bar{X}$: Mean value of data (error)
Xi : Data value
Ni : Data number for data Xi

a) It is clearly understood from the above equation that σ means the Mean Value of Variance of data. This might be more clearly understood if (N-1) is replaced by N in the equation.

Strictly speaking, σ is the mean variance of the measured data from the Mean Value of the measured data.

b) From this fact, the following analysis is possible. A large valued σ compared with the past record, means that there is a large variance in the fabrication method itself. The fabrication method shouId be reevaluated for uniformity and by personal opinion differences should be eliminated.



c) Example:

A large σ compared with the past record was detached at the length of the Longitudinal frames which were fabricated manually .

(Action)

Examine how and by whom these frames were made. The plan of the fabrication method should be fully investigated.

4) Feed Back

Through analysis of the measured data, suitable action should taken for the next unit and for the next ship. The following changes made from feed back due to Accuracy Control activity.

- o Change dimensions of excess materials (feed back to working drawing)
- o Add Base Lines in the output from Mold Lofting (feed back to Mold Lofting)
- o Change fabrication methods (preventing heat distortion, fabricating sequence)
- o Reinforce platform at Assembly.
- o Consider Cocking-Down in cribbing.
- o Adjust Gas Kerf compensation.

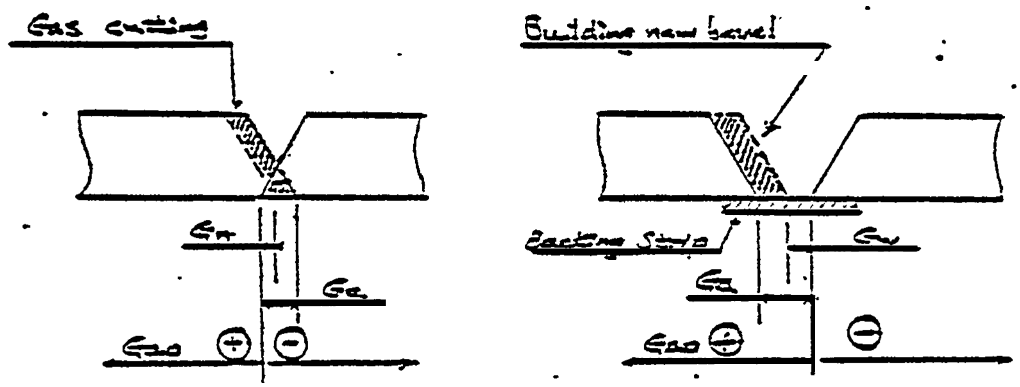
Accuracy Control Engineers are responsible for these actions. addition, it should be noted that these actions lead to a final (complete) plan and close a cycle (Accuracy Control Cycle).

PLAN ——> DO ——> SEE ——> ACTION

Through cycled activity, information and data is accumulated in the shipyard.

5) Tolerance on the Gap at Butt Welding

Though the meaning of the allowable tolerances on error may be easily understood, is may be interesting to note the gap tolerance at the butt weld.



(5-1

Ga $\leq$ Gn —— To be cut up to Ga

Ga $>$ Gw —— To be built up normal bevel using backing strip

Gn $<$ Ga $<$ Gw —— Normal welding

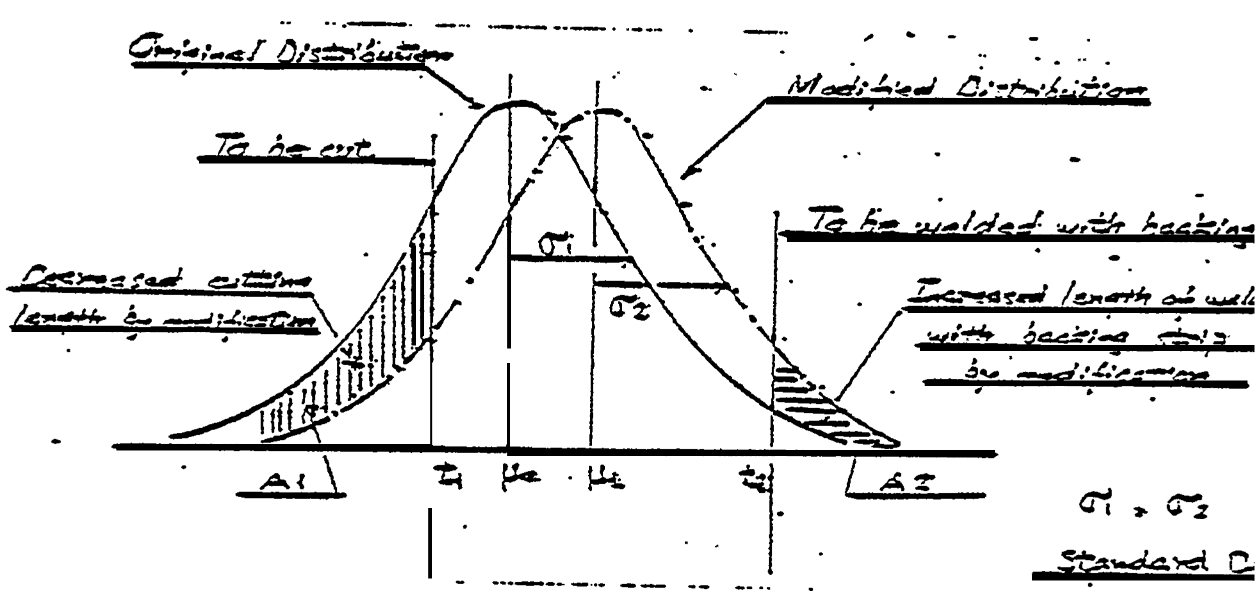
Ga is actual gap.

Therefore, Gn is the lower limit and Gw is the upper limit of tolerance on the root gap for welding.

5) Tolerance on the Gap at Butt Welding (Continued)

(5-2) Modification of distribution of errors according to the change of fabrication method.

Distribution of Errors



As shown in the above figure, distribution of errors can be int tionally changed by modification of fabrication method.

When the original distribution is supposed to indicate length o butt welding at erection, the ratio between "gas cutting" and "welding with backing strip" can be intentionally changed only treating the mean value being shifted without any other treatme

This suggests, that in case' welding with a backing strip is more easily accomplished than gas cutting for erection work, it is recommended that the mean value of gap in the direction of decreasing gas cutting be shifted.

Moreover taking into account the standard deviation σ_1 and σ_2, A_2 becomes much smaller than A_1 in the modification of the distribution.

ACCURACY CONTROL

CHECK POINT CHECKING DIMENSION, CHECKING METHOD

BASED ON FABRICATION SEQUENCE

FOR FUTURE-32 BULKERS

(1) Check point, checking dimension and checking method at Sub-assembly and Assembly based on he fabrication sequence of a unit.

(2) The same information at Erection.

(3) How to do shipwrighting based on the erection sequencs.

(4) Vital points at fabrication phase (Marking, Gas Cutting. and Sub-Assembly) and Base Lines to be involved in the output from Mold Lofting.

PREPARED BY IHI

REF. NO. KCT037

ACCURACY CONTROL

CHECK POINT. CHECKING DIMENSION, CHECKING METEOD BASED ON FABRICATION SEQUENCE FOR FUTURE-32 BULKERS

This paper *is to* display a concrete method to proceed the activities of Accuracy Control for the Future-32 Bulkers. In this paper, the follwing information is involved.

(1) Check point, checking dimension and checking method at Sub-Asssmbly and Assembly based on the fabrication sequence of a unit.

(2) The same information as (I) at erection.

(3) How to do shipwirghting bsed on the erection sequence.

(4) Vital points as fabrication phase (Marking, Gas Cutting and Sub-Assembly) and Base Lines to be involved in the output from Mold Lofting.

This kind of paper is designed by Accuracy Control Engineers in IHI not only for Future-32 Bulkers but alos any kind of ship. This activtty of Accuracy Control through this procedure *is called "special* control" which means "specially designed procedure for the Future-32 Bulkers". "Special Control" is contrasted with the "Regular Control which is proceeded by ordinary allowable- tolerance control and from which "Special Control" is derived.

2) Actual activities

In order to get clearer pictures in order to understand the practical method of the accuracy control activities, the nominated experts group of NASSCO performed the A/C process under the conduct of the IHI engineers.

Following activities were actually performed:

* Design unit assembling method
* Design data sheet for measurment
* Analysis of measured data

We are convinced that NASSCO can apply this to the other actual units in the same manner by themselves.

With repsect to the above, more detailed description is presented in the following chapters.

3) Connetion with Line Heating Technology

Line heating technology was also transfered to NASSCO by another IHI team. It should be reminded that the technology is an effective and powerful one to support A/C activities in the process Of hull construction.

It has two main aspects of functions in it. The primary one is, of course, to bend precisely and economically curved plates of not only simple curvature but also tight-complexed curvature. The secondary one is to straighten the deformation caused in the process of hull construction. The important here is to straighten the deformation in the earlier phase as possible without leaving it to the succeeding phases.

With respect to bending curved plates by line heating technology, more suitable templates must be prepared by adding the required data to the present templates in the Mold Loft.

From the view point as desrived in the above, it is recommended that application of line heating technology and preparatory works for it are integrated in the total A/C activities.

1. <u>Design Unit Assembling Method</u>

Unit assembly method should be studied before the start of assembly. In addition, the study of facilities where the unit is built should also be involved since the assembly method depends on the facilities.

The following should be clearly described in the unit assembly method:

1) Assembly sequence
2) Welding sequence
3) Vital dimensions

In studying the critical itmes described above, the following points should bee considered:

1.) Platen for assembly:

When a platen and jigs are set up, the shape and size of a unit should be considered as follows:

- Flat/curved
- size of unit
- weight
- Assembling status of the webs such as the height, weight and loading direction.
- Condition of the internal members.

2) Landing sequence of pieces to be assembled: An appropriate method to set preventive supports, suck as strong backs, should be studied.

3) Welding scheme: - The most important consideration here is to select carefulLy the proper welding method and sequence in order to mimimize deformation.

4) Assembling sequence: - Through the study of the assembling sequence, vital points and vital dimensions are noted. Any discrepancies betweem drawing implied sequence and assembling sequece is checked beforehand .

5) Guarantee of welding quality and maintenance of vital dimensions.

unit assembly method should be designed with these conside-rations in mind.

2. Design Data Sheet

The numoer of dimensions to be checked varies depending on the capability of the shipyard. It is recommended that NASSCO check as many dimensions as possible until they determine their particular required accuracy.

C

3. <u>Analysis</u>

Analysis of the measured data is not only for recognition of the present accuracy but also for finding problems and solving those by comparing measured data with the standard allowable tolerance of NAssco.

The important point is that all related personnel should communicate openly with each other without hiding the facts and without unfair blaming.

Since NASSCO has not yet established a clearly defined standard the following recommendations are lmited to problems actually found by IHI and to areas where potential problems could arise.

C.

4. <u>Exercise 1 (Flat unit)</u>

Tbe following is a procedure on the A/C activities on a main deck unit.

1) Design unit assembling method. Refer to Appendix 1 (AP 1-1)

2) Design data sheet. Refer to Appendix 1 (AP 1 - 2 to AP 1-15)

3) Analysis . Refer to Appendix 1 (AP 1-16 to AP 1-18)

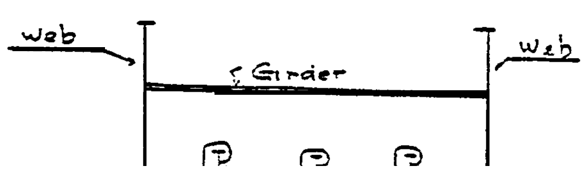
4) Noted problems:

a) Platen for assembly is <u>not level</u>.

During the time of discussion with the members of Team #2 (experts group), the platen was said "to be flat" by all of them. However, in fact, it was found not to be flat when measured. IHI recommends checking all platens and adjusting.

b) Additional work was required for inaccurrately fabricated girders in relation to longitadiaal positioning.

As drawn below, girdes slots had to be gas cut during assembly because they were not aligned with the actual longitudinal placement. The NC tape produced by mold loft was found to be correct when checked against the drawing. Judging from this, the errors appear to have been caused by the NC burning machine. Therefore, the NC burning machine should be carefully and regularly checked. According to the machine operator, mechanisms such as the driving motors are a problem.

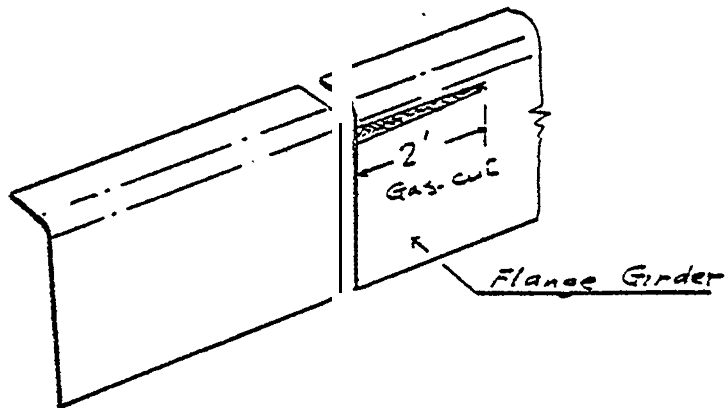


Since the NC burning machine is one of the most vital Pieces of equipment at NASSCO, it is strongly recommended that repair and recalibration be done as soon as possible.

c) Misalignment of the flange girders: As drawn below, the flange girders were misaligned at assesbly, so that the bent part of a 2' (two foot) length was gas cut at assembly. This misalignment is considered to have been caused by a bending error. Therefore, it is recommended that bending methods for flanges be reviewed and revised. Since a flange girder is very popular in NASSCO design, the accuracy of a flange girder (at fabrication) is vital.

d) Length of the pieces are inaccurate: As described in "analysis" of this chapter, control of length accuracy is lacking. It follows that the work load incurred by this error multiplies with each subsequent production process, because accuracy of length is the primary element of accuracy control. Therefore, it is necessary to attack the source of the errors.

It is recommended by IHI to check the burning process, not only NC burning, but also hand cutting.



C

5. <u>Exercise 2 (curved shell unit)</u>

Following is a procedure on the AC activities on a curved shell unit.

a) Design unit assembling method. Refer to Appendix 2 (AP-2-l to AP-2-2)

b) Design data sheet. *Refer* to Appendix 2 (AP-2-3 to AP-2-14)

c) Analysis.

d] *Noted* problems:

1) Pin/jigs are poor:

As described in our first survey report, the condition *of* Pin/jigs is poor. It should be improved as soon as possibie. The platen leveling is also poor, and it is strongly recommended this be corrected.

2) Calculating method for the jig-height:

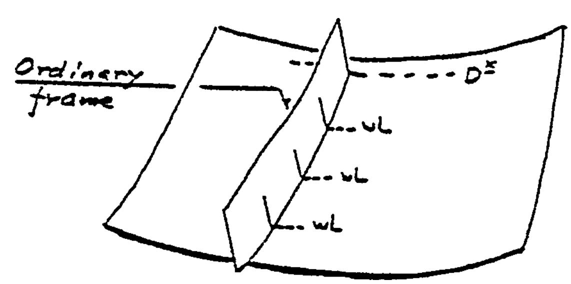
There exists no standard to determine the necessity of jigs for any given init curvature. in addition, there is no standard to establish the datum plane for jig height calculation and as a result, selection of jig height is left to the judgment of the loftmen. In reatity, it is reasonable and more efficient to·establish the datum plane following the assembling sequence.

3) Reference line:

The necessity and purpose of the reference line is not clearly understood by NASSCO. On an ordinary hull frame, these are many WL (water line) marks. However, the hull fitter does not use any of these lines but refers instead to the main deck line. His judgment is correct in making this choice and it is considered that marking the WL is a waste of time and promotes confusion. The same thing can be said in BL (buttock line).

It is recommended to minimize the number of reference lines`.

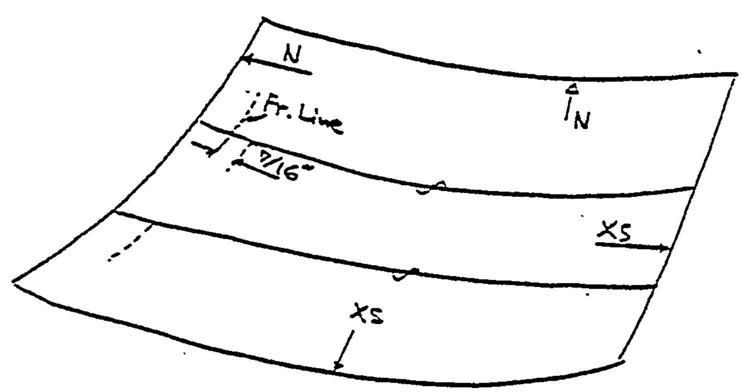
C



4) Discrepancy of the frame line marked on the plate:

As drawn below, a frane line was found to be in dicrepency by 7/16" - The frame line was very near the block butt which was neat cut.

It is considered that this was caused by the error of the NC burning.



C

6. Epilog

Through our activities with the experts group of NASSCo, NASSCO prepared the primary plan of how to proceed and how to implement the accuracy control at NASSCO as shown in the next two (2) pages.

IHI hopes that that NASSCO establishes its own accuracy control procedure along our recommendations.

We appreciate your kind cooperation especially the cooperation and help given by Team #2.

ACCURACY CONTROL (Prepared by NASSCO)

The Steering Committee consisting of J. Smith, A. Giorgis, K. Evans, C. Jensen, J. Lightbody, and K.K. Christensen recommends that Accuracy Control be implemented at NASSCO.

The degree of implementation is recommended as follows:

1. Short Term
2. Intermediate Term
3. Long Range Plan

Short Term is considered to include those areas where A/C can be instit with minimal or no cost and can be started almost immediately.

The following are felt to be examples of Short Term items which can be started and completed in about a 3-6 months' timeframe:

- o Documentation of Burning Machine Accuracy.
- o Production of more check tapes by computer.
- o Provide more dimensional information to Yard Operations for checking purposes, welding allowable tolerances.
- o Provide formalized methods for Yard Operations to feed back A/C problems.
- o Commence development of Standard Repairs documentation.
- o Commence development of plans for education in A/C Procedures.
- o Provide for inspection of steel plate upon receipt in yard for flatnes freedom from laminations, etc.
- o Define NASSCO's capability to maintain Accuracy Control:
  - a. Under current facility constraints.
  - b. With upgraded facilities/cost.
- o Continue training in line heating without an automated facility.
- o Develop interim Working Practice/Procedures/Standard formats/Date analysis techniques, etc.

Intermediate Term is considered to include those areas where accuracy can be increased at some nominal cost and within some reasonable time, e.g., 12 months. The following are felt to be examples of Intermediate Term items:

- o Upgrade of Platen (i.e., level platen area)
- o Upgrade of burning equipment.
- o Upgrade of Pin/Jig platen.
- o Development and publication of NASSCO A/C Standards, including:
  - a. Excess allowances including shrinkage.
  - b. Fabrication, Production and Working Practices for all Departments.
  - c. A/C Tolerances
  - d. "Repair" Manual
- o Publication of "pocket sized" manual to be distributed to the field.
- o Implementation of Education Program in Yard Operations.
- o Development of an Automated Line Heating Facility.
- o Development of Management Reports.

A Long Range Plan is considered to be activities beyond a one year time frame. The following are considered to be examples:

- o An analysis (overview) of the first year of operations with recommendations for the future.
- o A revision to the A/C Standards, tolerances and Working Practices should be approved, published and distributed.
- o The Accuracy Control Standards book should be submitted to the Regulatory Agencies for approval.
- o Upon approval, these Standards should, by reference, become a part of Ship Specifications and Contract Terms and Conditions.
- o A capital expenditure plan for upgrading of facilities should reflect, in part, those deemed necessary to support Accuracy Control.

MEANS OF IMPLEMENTATION

- o The implementation of A/C would be through an organization which would be a part of Yard Operations.
- o This organization should be formed immediately, headed by the eventual Chief of Accuracy Control.
- o This Chief would coordinate the efforts of the A/C Committee (Team #2) to remedy the defects of the Short Term Plan. As the organization evolves, it would take over the functions of Accuracy Control.
- o The Steering Committee would be appraised regularly of progress and direction and would remain in an advisory capacity to the A/C Group.

COST OF IMPLEMENTATION

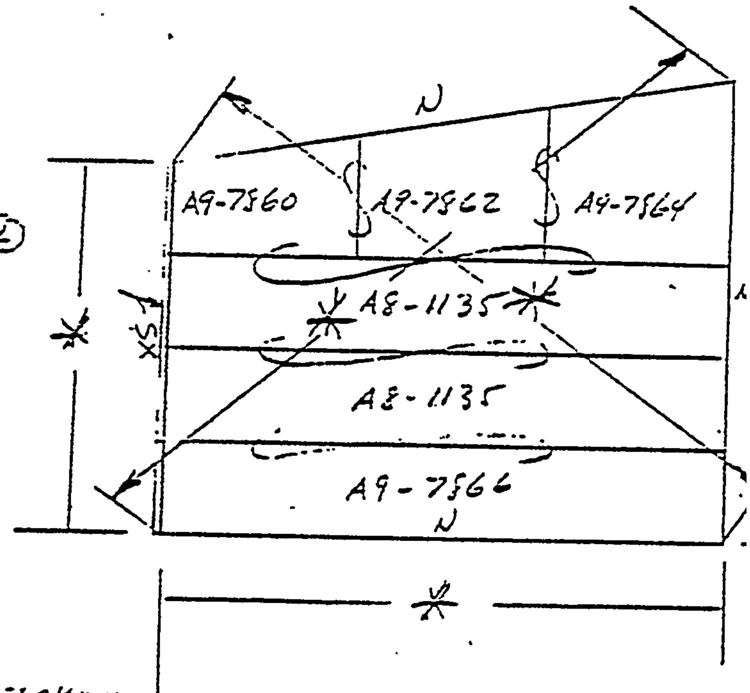
The immediate needs are for four technicians and a Manager or Chief, transferred from other duties within NASSCO. Office space, telephone and access to reproduction/printing capabilities are required. Estimated Short Term Costs are:

Leader (Supt level)	$ 30,000
Four (4) Technicians (FM level)	$ 72,800
Clerk typist	$ 8,800
Office Furnishings	$ 2,000
	$113,600
Overhead (106%) of Labor	118,300
TOTAL	$231,900

Offset - The cost referred to above, translated into manhours at $20/hour, is equal to 11,600 hours. The approximate cost of $232,000 would appear to be easily offset by the savings of 12,000 hours. For example, the manhour estimate for the Carlsbad Class for cost numbers in the 100 series is 372,000. The three (3) ships, the estimate is 1,116,000 manhours. Thus, the equivalent cost is 1.03% of the total fabrication, subassembly, erection and fitting costs of the 3 Union Oil Product Carriers.

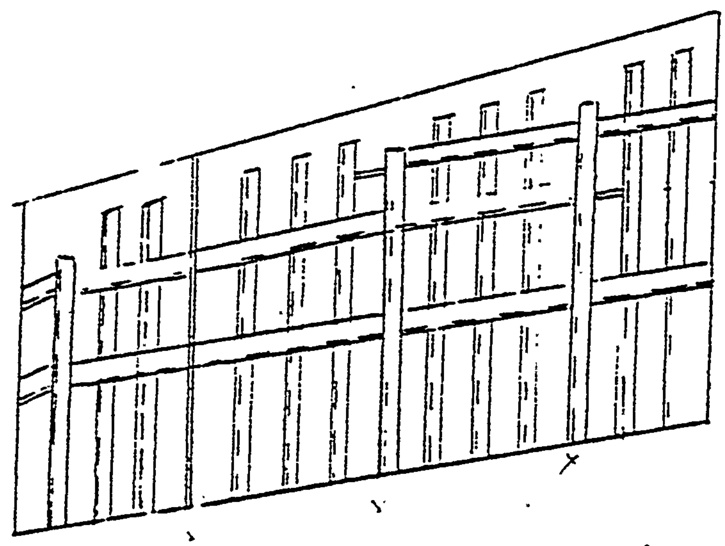
ASSY A2-503(P)

1. LAND RAILS
2. FIT A9-7860+7862+7864
3. WELD A9-7860+7862+7864 } ①
4. FIT A8-1135+A8-1135+ A9-7866
5. WELD A8-1135+A8-1135+ A9-7866 } ②
6. FIT ① + ②
7. WELD ① + ② } ③
8. CHECK VITAL DIM *
9. LAYOUT.



1. BRING FAB- INTERNAL MEMBER TO PANEL.
   (a) ORDINARY FRAME
   (b) WEBS
   (c) GIRDERS
   (d) BHD MARGIN

2. FIT AND WELD ORD. FRAMES
3. FIT GIRDERS
4. FIT WEBS
5. WELD ALL VERTICALS IN ACC WITH REF #
6. WELD GIRDERS
7. WELD WEB & BHD MARGIN.

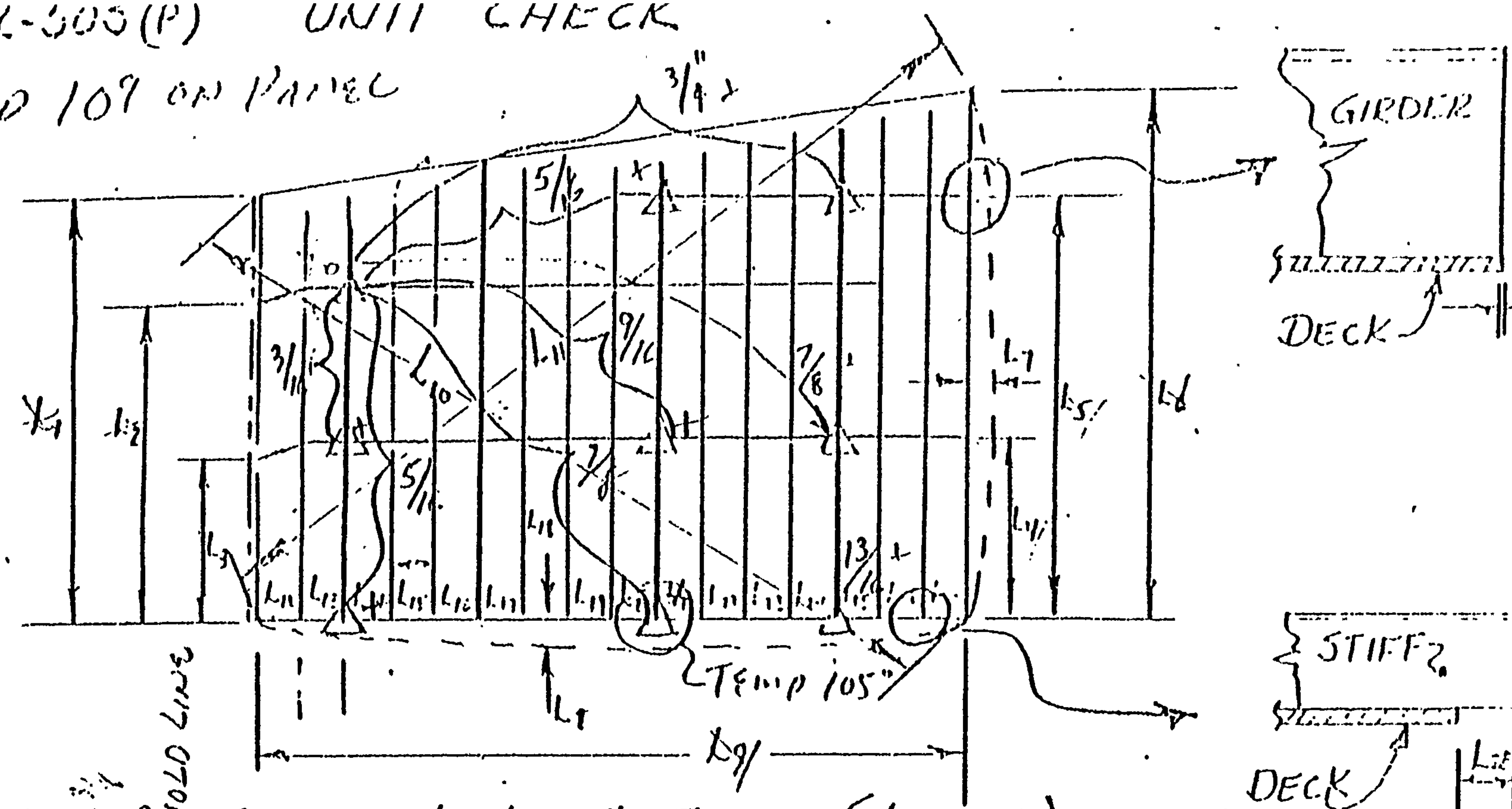


NOTES - CHECK FLATNESS & LEVEL OF UNIT AFTER FITTING & AFTER WELDING.

ASSY AZ-303(P) UNIT CHECK

TEMP 109 ON PANEL

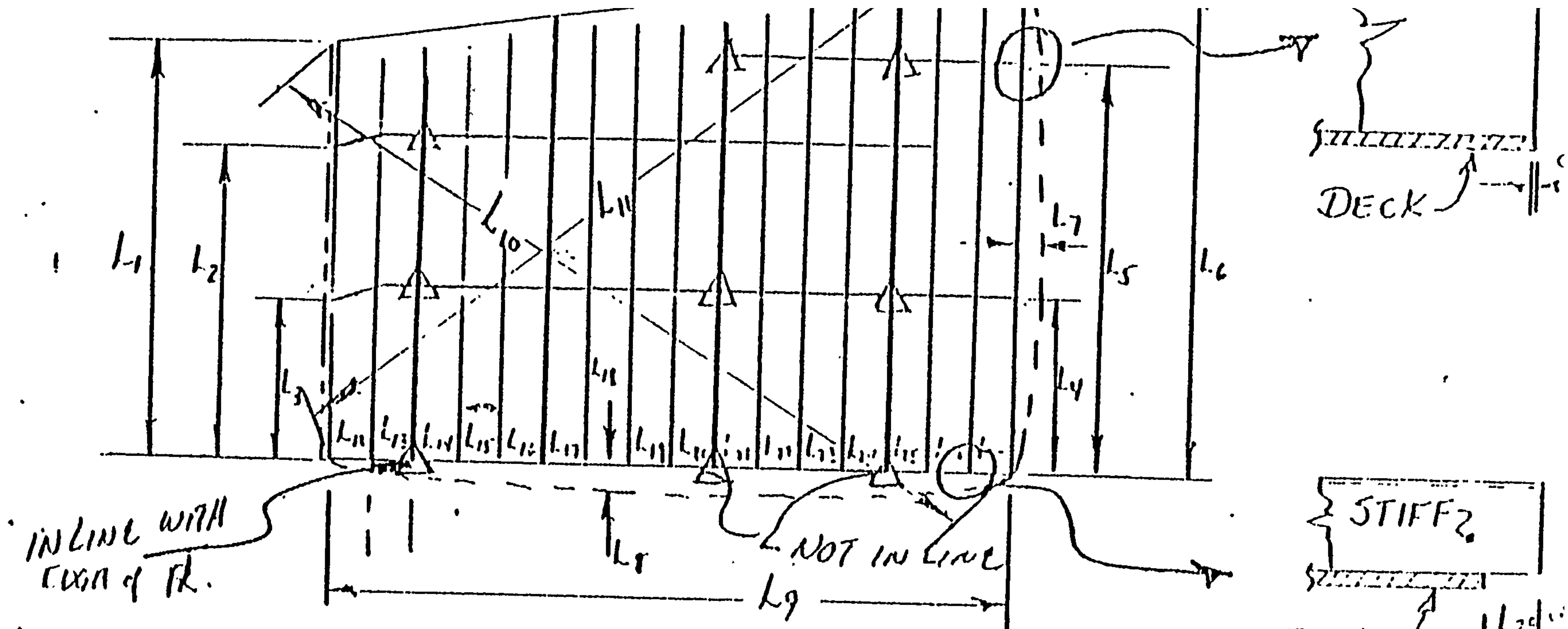
AP-1 2



NOTE △ REF. POINTS TO CHECK FLATNESS (LEVEL)

DES DIM	ACT DIM	△ DEV	℄ CL
31'-6 7/16"	31'-7 1/16	+ 5/8	
23 ?/8'	23'-2 5/8	+ 2/4	
14'4 1/16"	14'-4"	- 1/16	
14'-7 1/2"	14'-7 3/4	- 1/8	
29'-[illegible]"	29'-9 3/4	- 1/8	
38'-4 ?/16"	38'-4 5/16	- 1/8	
		1/4"	
35'-9"	35'-8 7/8	- 1/8	
?'-8 1/16	47'-3 1/16	0	
52'-C ?/16	52-4 15/16	- 3/8	
2-0"			
2-6"			
2-6"	33'-8 7/8	0	
2-6"	31'-3 7/8	+ 1/8	
2-6"	25'-8 3/16	- 1/8	
2-6	26-2 7/8	+ 1/16	
2-6"	23'-8 [illegible]	- 1/16	
2-6"	21'-2 7/?	0	
-2-6"	[illegible]'-7 [illegible]	0	

AP-1 3

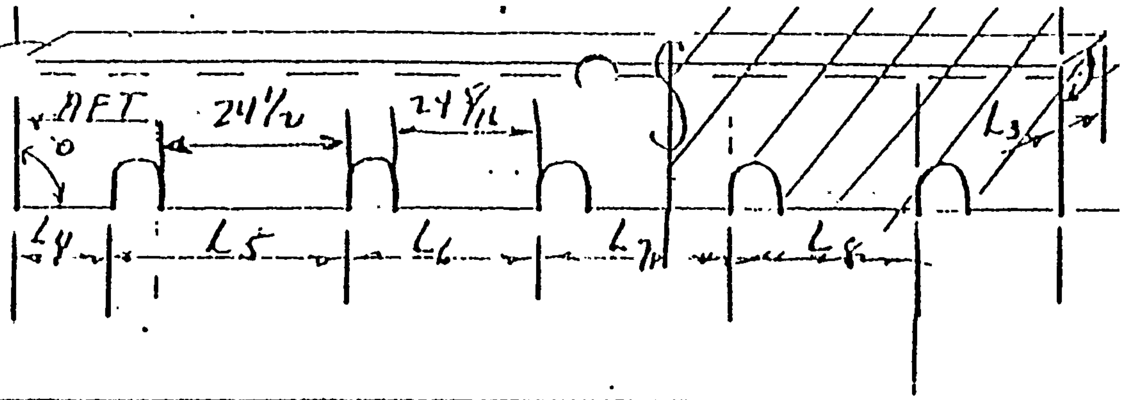


NOTE △ REF. POINTS TO CHECK FLATNESS (LEVEL)

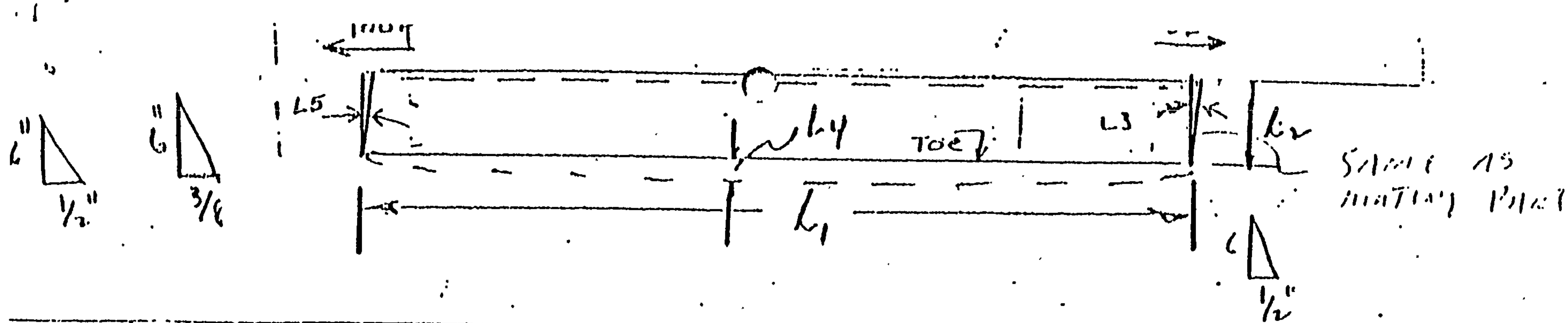
DIM	DIM	DEV	ΣL
2'-6"	16'-2 1/8	0	
2'-6"	13'-8 7/8	+ 1/16	
2'-6"	11'-2 13/16	- 1/16	
2'-6"	8'-8 7/8	0	
2'-6"	6-2 7/8	- 1/16	
2'-6"	3'-8 15/16	+ 1/16	
1'-3"	1'-2 7/8	- 1/8	

C

GIRDERS
UTS FROM
1C TAPE #
11-0788-2



RT	L	DES. DIM.	ACT DIM	Δ DEV.	Δ AL	θ_D	θ_A	CHECKED	REMARKS
13677 13678	1	9'-0 3/4"	8'-11 5/8	- 1 1/8"					
	2	24"	24 7/16 ~~24-1/4~~	? 7/16					
	3	4"	4"	-0-		97°			
	4	1'-5 7/8"	1-5 3/16	- 11/16"		90°			CUT OUT HAD HAND BU
	5	2'-6 1/4"	2'-6 1/4	-0-					
	6	2'-6 1/4"	2'-6 1/8	- 1/8"					
	7	2'-6 3/8"	2'-6 1/4	- 1/4"					
	8	4"	4"	-0-		45°			

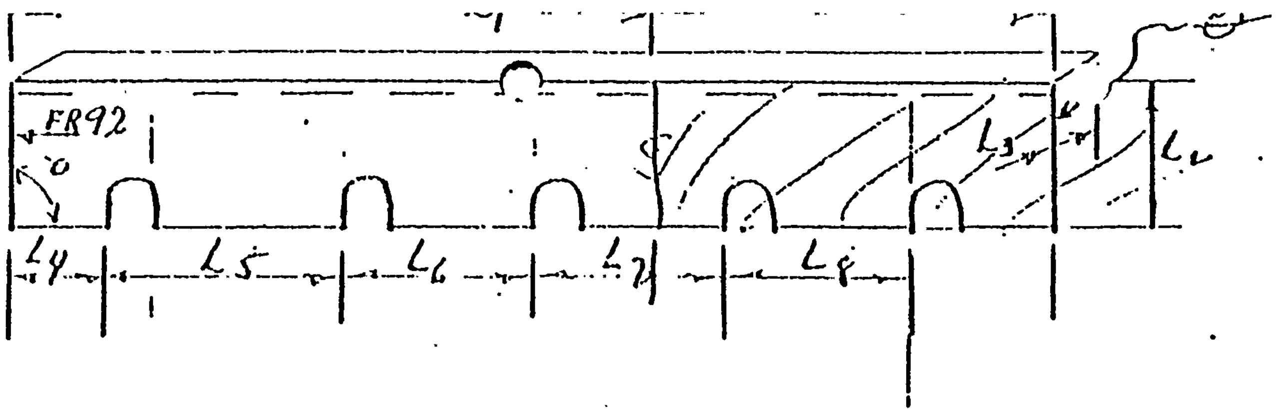


PT		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
-1157 -1158	L-1	18'-7 7/8"	19'-5 7/16	-1/8 -1/4			19'-6 1/8"
	L2	36"	35 7/16 36	-1/8 0 0 0			36 1 36
1/5	L3	4°	4° 48' 4°				
	L4						
	L5	4°	4° 48'				
3023(F) 024(S)	L-1	15'-9 1/2"	15'-9 9/16	-1/16			
91 1/5	L2	36"	35 11/16 36 1/16	-5/16 +1/8			
	L3	4°	3° 35'				1" 1/4"
	L4						
/	L5	4°	4° 31'				1" 1 1/4

AP-1 S

GIRDERS

UTS FROM
Vc TAPE
21 0804-1



RT	L	DES. DIM.	ACT DIM.	Δ DEV.	Δ AL	Θ_p	Θ_L	CHECKED	REMARKS
7103 7902	1	9'-11½"	9'-11 5/16	-3/16"					
	2	2 4"	2-1⅛"	+⅛"					
	3	4"	1-4⅛"	+⅛		90°	89°		
	4	2'-5⅜"	2'-5⅜	-0-		90°			
	5	2'-6"	2'-6⅛	+⅛"					
	6	2'-6"	2'-6⅛	+⅛"					
	7	2'-6⅛"	2'-6	-⅛"					

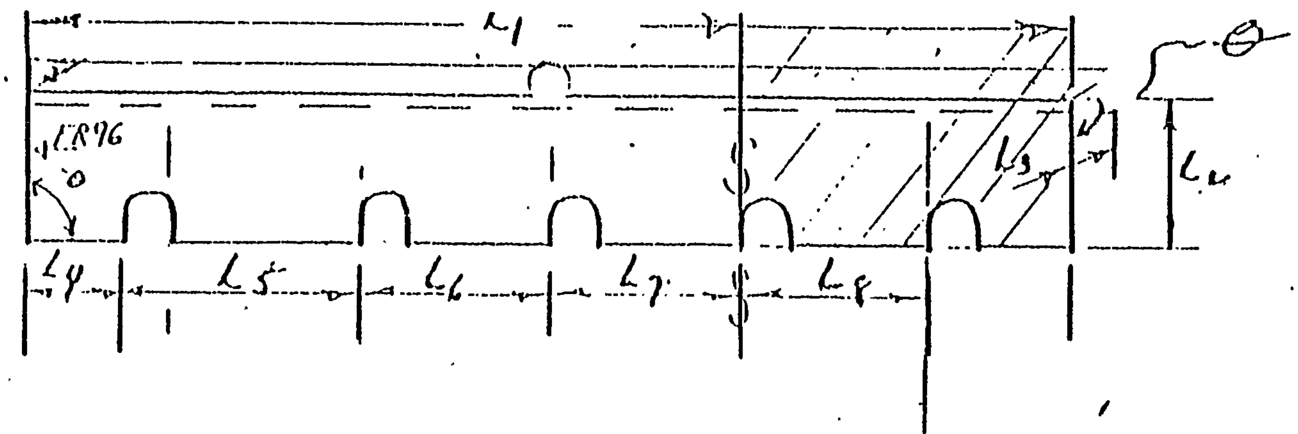
AP-1 6

GIRDERS

UTS FROM

& TAPE #

1-0788-2



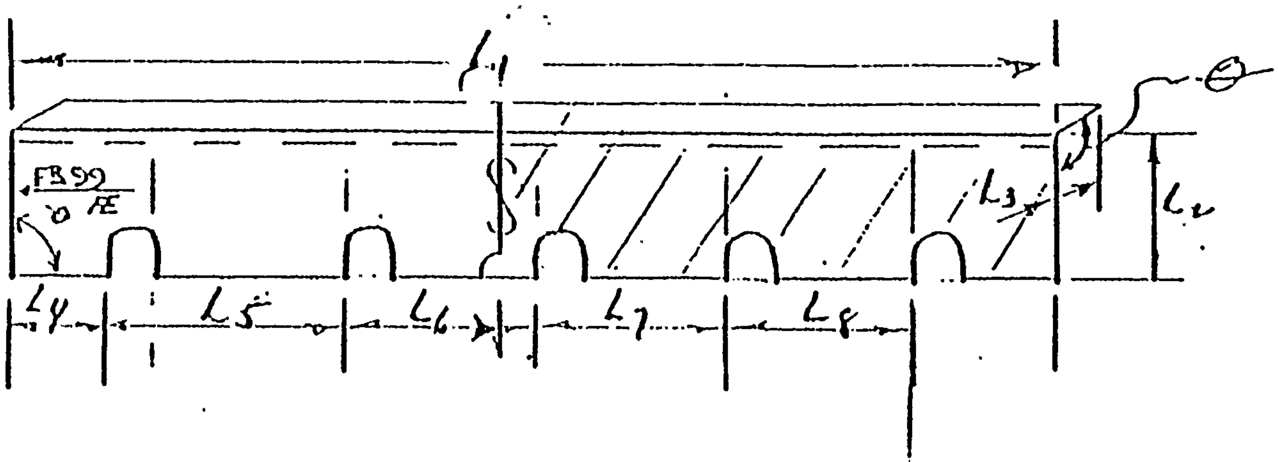
RT	L	DES. DIM.	ACT DIM	Δ DEV.	Δ ΔL	θP	θ	CHECKED	REMARKS
7909 7910	1	9'-11 9/16"	9'-11 1/4	- 5/16"					
	2	24"	24 1/8	+ 1/8"					
	3	4"	4"	-0-		90°	89°		
	4	2'-5 7/16"	2'-5 3/8	- 1/16"		90°			
	5	2'-6"	2'-5 7/8	- 1/8"					
	6	2'-6"	2'-6	-0-					
	7	2'-6 1/8"	2'-5 7/8	- 1/4"					

AP-1

7

GIRDERS

CUTS FROM N/C TAPE # 21-0789



PART	L	DES. DIM.	ACT DIM	Δ DEV.	Δ AL	θ_p	θ	CHECKED	REMARKS
AD-7511 AD-7512	1	7'-5 1/2"	7'-5 5/8	+ 1/8					
	2	24"	24 1/4 24 3/16	+ 1/8					
	3	4"	4 1/8	+ 1/8	90°	90°			
	4	2'-5 3/8	2'-5 3/4	+ 3/8	90°				
	5	2'-6"	2'-5 1/4"	- 1/4					
	6	2'-6 1/8	2'-6 1/4"	+ 1/8					

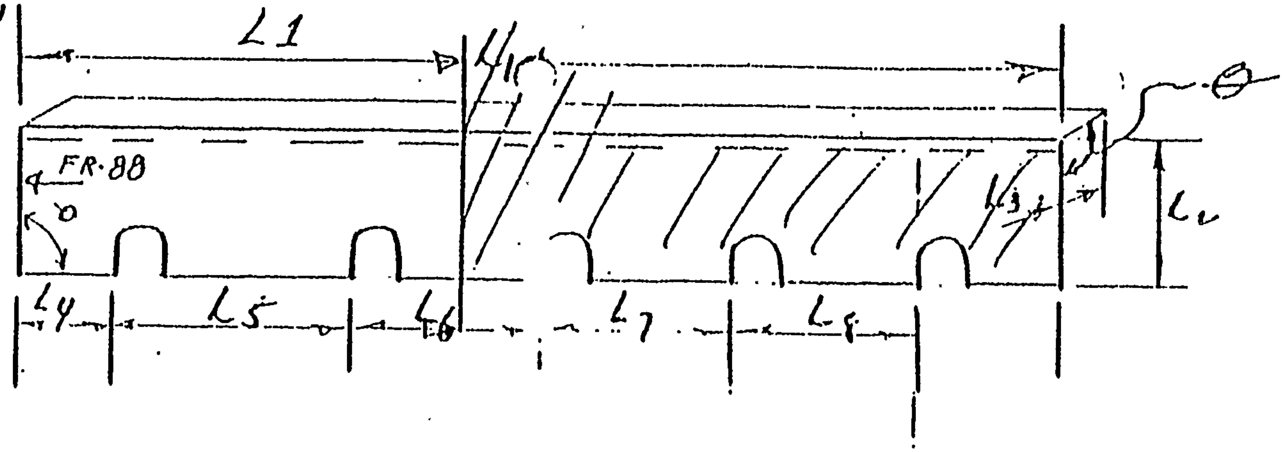
ASSY :-5050(?)

GIRDERS

CUTS FROM

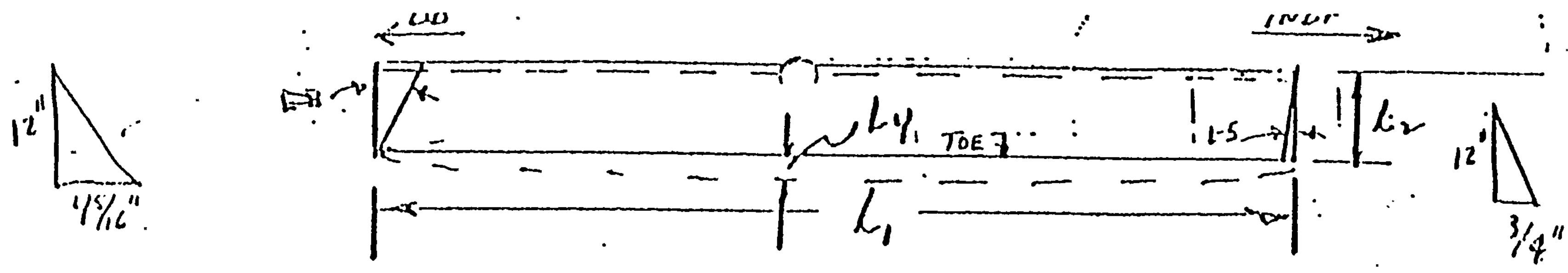
NC TAPE #

21-0787-1



PART	L	DES. DIM.	ACT DIM	Δ DEV.	Δ ΔL	θ_D	θ_L	CHECKED	REMARKS
11-7941 / 9-7942	1	6'-2½"	6'-2½"	0					
	2	24"	23¾" / 24	-¼					
	3	4"	4⅛	+⅛		90°	90°		
	4	2'5⅜"	2'5½ / 2'-5 1/16	+ ⅛ / - 5/16		90°	90°		
	5	2'-6"	2'6 / 2'-5⅞	- ⅛					
	6	1'-3⅛"	1'-3" / 1'-3½	- ⅛ / + ⅜					

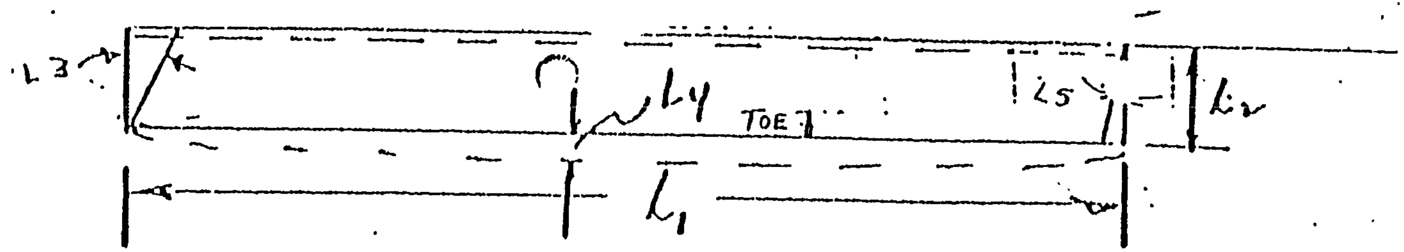
AP-1 9



PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER WT.	REMARK
-7971 (P) -7972 (S)	L1	13'-0 1/16"	13'-1 1/8	+ 1 1/16			MARKED 1 1/2" x S
72 P/S	L2	36"	36 1/16 36 1/8	+ 1/16 + 1/8			
	L3	22°	21° 4'	56'			12" 1 1/4"
	L4						
	L5	4°	3° 35'	25'			SEE ABOVE
-7973 (P) -7974 (S)	L1	14'-10 7/8"	14'-10 7/8	0			
55 1/1	L2	36"	36 5/16	+ 5/16			
	L3	20°	21	1°			
	L4						
	L5	1°	3° 35'	25'			

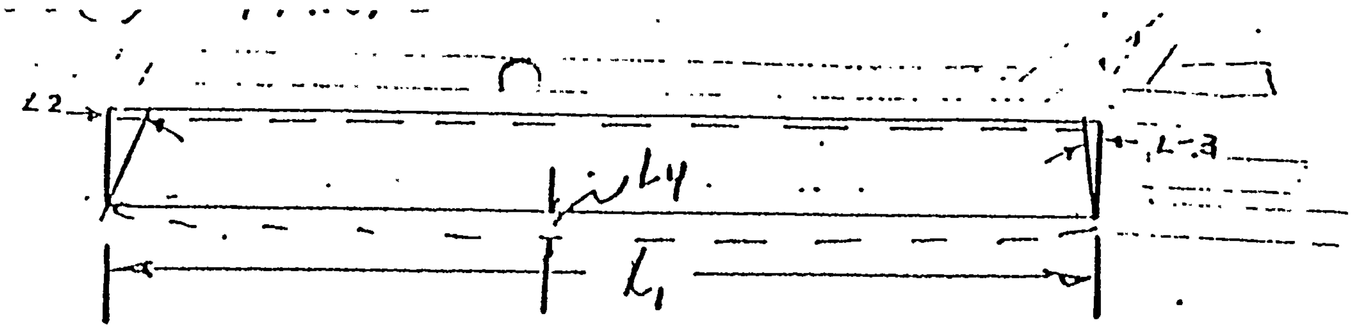
AP-1

10



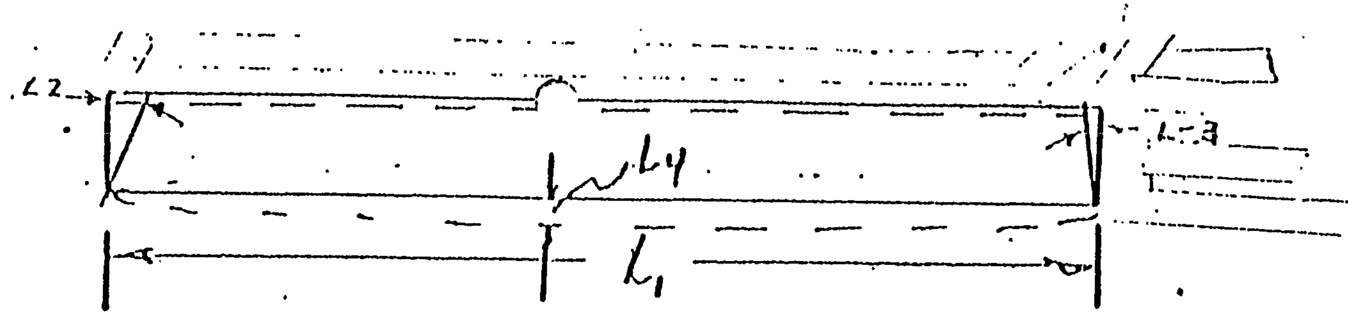
PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
49-8017 (P) 49-8018 (S)	L-1	12'-11 1/16"	12'-10 3/4	- 5/16			NO XS MARKED ?
FR 99 P/S	L2	36"	36 35 7/8	-1/8			12 6 1/2"
	L3	28°	32° 48'				
	L4						
	L5	4° (-)	3°35'				12 3/16

AP-4 11

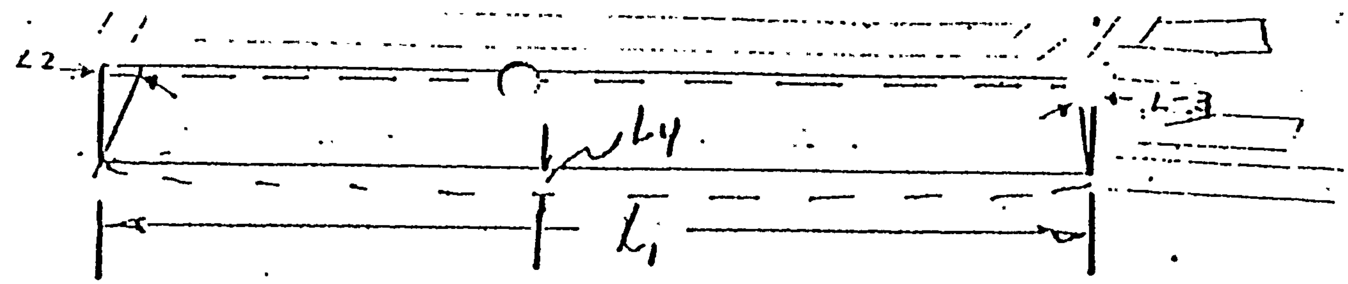


PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
AQ-8051 [illegible]	L1	37'-0 11/16	37'-0 1/2	$-\frac{5}{16}$			
	L2	14°	12°36'				7/8
	L3	4°	3°35'				1/4
	L4						
AQ-8053 FR 87	L1	36'-8 1/4"	36'-8 1/8	$-\frac{1}{8}$			
	L2	14°	14°30'				1"
	L3	4°	4°30'				5/16
	L4						
AQ-8055 FRE 9	L1	35'-10 3/4	36-10 3/8	$-\frac{3}{8}$			Cam out of [illegible] lens
	L2	14°	16°20'				1 1/8
	3	4°	4°30'				1/16

AP-12



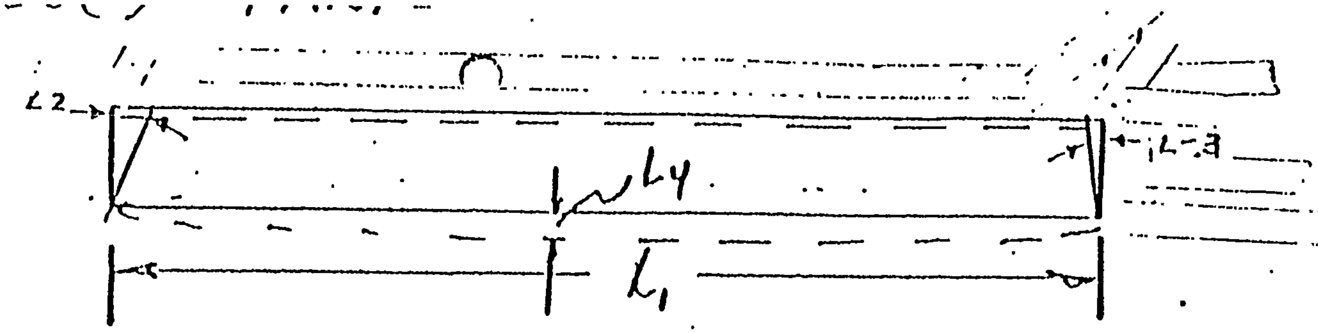
PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
97-8057 FR 90	L1	35'-5 1/2"	35'5 9/16	+ 5/16			
	L2	15°	14°30'				1"
	L3	4°	2°42'				3/16
	L4						
97-8059 FR 91	L1	35'-0 5/16"	35'-0 1/4"	− 1/16			
	L2	15°	14°30'				1"
	L3	4°	2° 42'				3/16
	L4						
A9-8061 FR 93	L1	34'-1 3/16"	34'-1 3/8	+ 3/16			
	L2	16°	14°30'				1"



PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
A4-8063 FR 94	L1	33'-7 3/4"	33'-7 6/8	+ 1/4			
	L2	17°	15° 40'				1 1/16
	L3	4°	3° 35'				1/4
	L4						
A4-8065 FR 95	L-1	33'-1 1/8"	33'-1 1/8"	0			
	L-2	17°	15° 40'				1 1/16
	L-3	4°	3° 35'				INBD BEV. 4" 1/4
	L-4						
A4 8067 FR 97	L-1	32'-0 5/16"	32'-1"	+ 11/16			
	L-2	18°	17° 16'				1 3/16
	L-3	4°	3° 35'				1/4
	L-4						

AR-1 14

10671



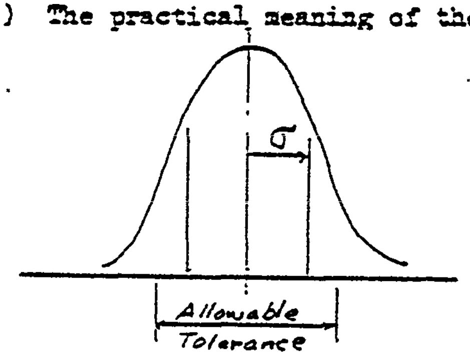
PART		DES. DIM.	ACT DIM.	Δ DEV	Δ AL	CHECKER INT.	REMARK
DG-E059 FIL 78	L_1	31'-5 5/8"	31'-6 5/8	+1"			? DESIGN INPUT.
	L_2	18°	3° 35'				1/4"
	L_3	40°	18° 20'				1 1/4"
	L_4						

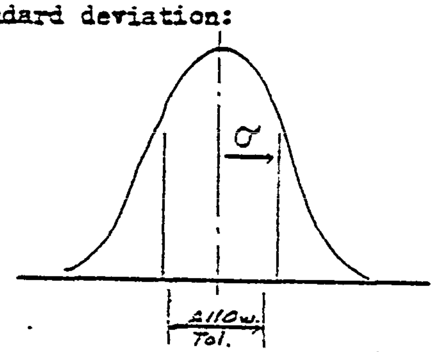
Data Analysis AP-1-16

First, the measured data is rewritten into the table for data analysis which is convenient to calculate. (See Table 1). As seen in the table, there are four errors outside the effective range. These should be eliminated since they are mistakes and not a problem of accuracy.

For this measurement, ± 2/16" is considered to be the appropriate range of the errors in the coordinate system of "error frequency". Then the mean value of errors is calculated and by using that the standard deviation value is easily calculated. The relationship among this distribution of errors, the mean value of the errors and the standard deviation value is shown in Figure 1. This figure shows the following:

1) The mean value of errors is 1.2/16".
2) The value of the standard deviation is 3.8/16". This means that about 2/3 of all the data is within ± 3.8/16" from the mean value (-1.2/16").
3) The practical meaning of the standard deviation:





When the standard deviation is within the allowable tolerances, the accuracy is good enough or the allowable tolerance is too loose (See (a)). When the standard deviation is out of the allowable tolerance region, the requested accuracy is not satisfied or the allowable tolerance exceeds the capability of the shop.

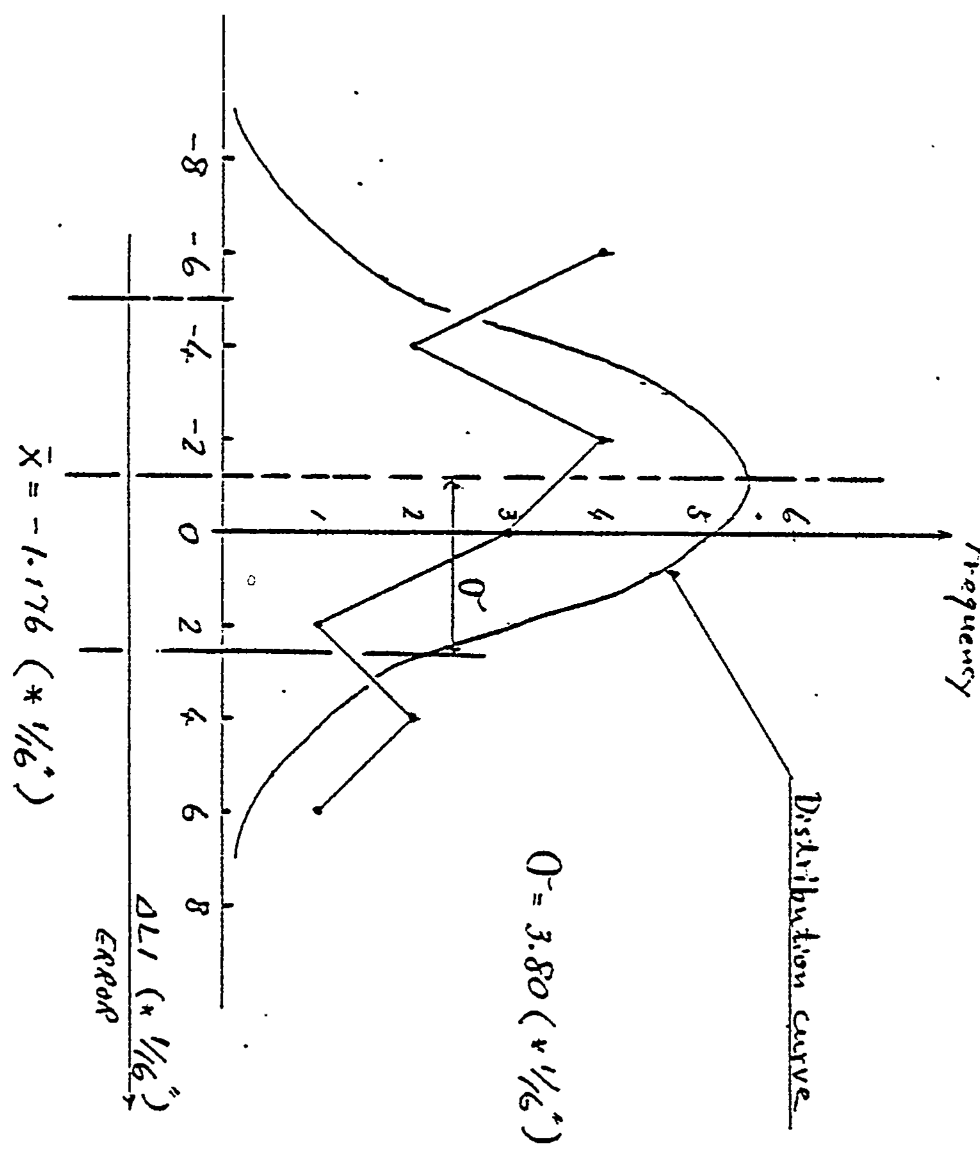
Thus the allowable tolerance should be decided taking into account both the requested accuracy and the capability of the shop.

(Table-1) TABLE FOR DATA ANALYSIS

Error ΔL_i	Frequency f	$(*1/16")$ $\Delta L_i - \overline{\Delta L_i}$	$(\Delta L_i - \overline{\Delta L_i})^2 * f$	
✓ −24/16	1			Mistake
✓ −18/16	1			
−6/16	1	−4.8	92.16	Effective data
−5/16	3			
−4/16	1	−2.8	15.68	
−3/16	1			
−2/16	2	−0.8	2.56	
−1/16	2			
0	3	1.2	4.32	
+1/16	0	3.2	10.24	
+2/16	1			
+3/16	1	5.2	54.08	
+4/16	1			
+5/16	1	7.2	51.84	
✓ +11/16	1			Mistake.
✓ +16/16	1			
$\overline{\Delta L_i}$ = −1.176/16 ≒ −1.2/16	N = 21 − 4 = 17		230.88	

AP-1 18

Fig -1


Frequency
Distribution curve
σ = 3.80 (* 1/16")
x̄ = -1.176 (* 1/16")
ΔL1 (* 1/16")
ERROR

1> CUT PLATES BY N/C

2> ROLL PLATES AT ROLLS
2(a) FAB. BRTS & COLLARS

3> CHECK PIN JIG

4> ALIGN PLATE to REF. FRAME THEN WELD (SAW)
(A9-2302 + A9-2304 + A9-2306)

5> RECHECK FOR EXACT POSITION OF PANEL ON P.
& CHECK DIAGONALS.

6> CHECK LAYOUT & CLARIFY.

7> FIT FRAMES (ORD) A9-2365, A9-2367, A9-2369,
A9-2373, A9-2375, A9-2377,
A9-2381, A9-2383, A9-2385,
& A9-2389,
ALSO FIT WEB - A9-2402 & A9-2404
C ALSO FIT STGR - A9-2316, A9-2318 & A9-2320
FIT COLLARS & TRIPPING BRKTS & LOWER BRK
(A8-885) (A9-2334 & A

8> RECHECK PIN JIG AFTER FITTING WORK ACCOMP.

9> BEGIN WELDING:
ⓐ ALL VERTICAL WELDS (IAW REF. #) INCLUD.
COLLARS (SHORT ARC) GMW
ⓑ WELD TRIPPING BRTS (MMA)
ⓒ WELD ORD FRAMES & WEBS. IAW REF # (AUTO
ⓓ WELD STRG'S (MMA)
ⓔ WELD LOWER BRTS. A9-3968, A9-3970
NOTE! UPPER BRT'S. SHIP LOOSE. TACK TO UN

10> DIMENSION CHECK UNIT.

A2-463 AP-2 - 2 SHT - 37

⟨11⟩ TURN ASSY THEN FINISH WELDING SEAM IAW REF

⟨12⟩ CHECK UNIT

⟨13⟩ CHECK SHIP to RECIEVE UNIT.

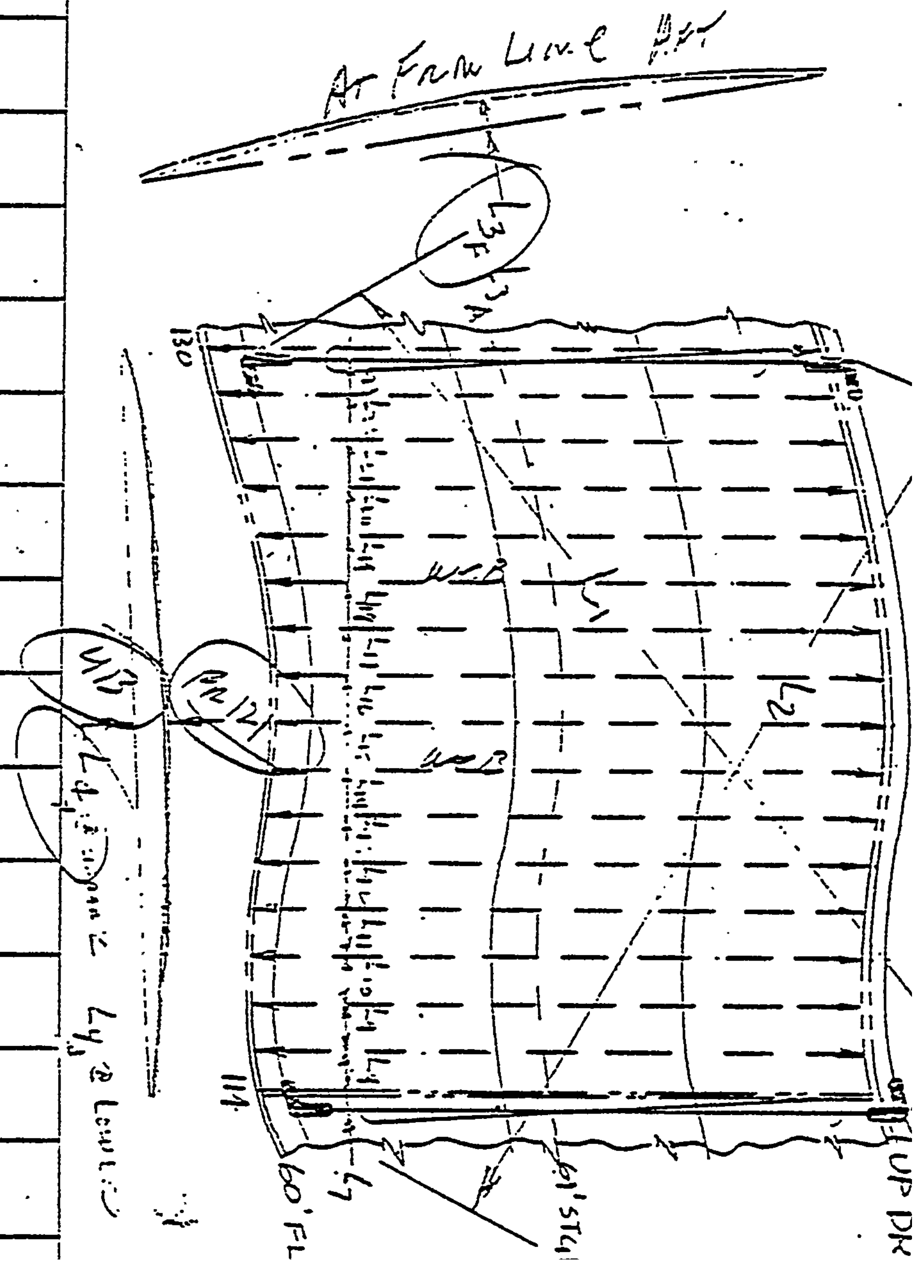
⟨14⟩ TRIM UNIT AS NECESSARY.

C

L	DIM	ACUT DIM	DEV	AL
L1				
2				
3F		10 5/8"		
3A				
4U				
4B		2 7/8"		
5				
6				
8		25 5/16		
9		25 5/16		
10		25 5/8		
11		25 5/16		
12		25 9/16		
13		25 5/16		
14		25 13/16		
15		25 11/16		

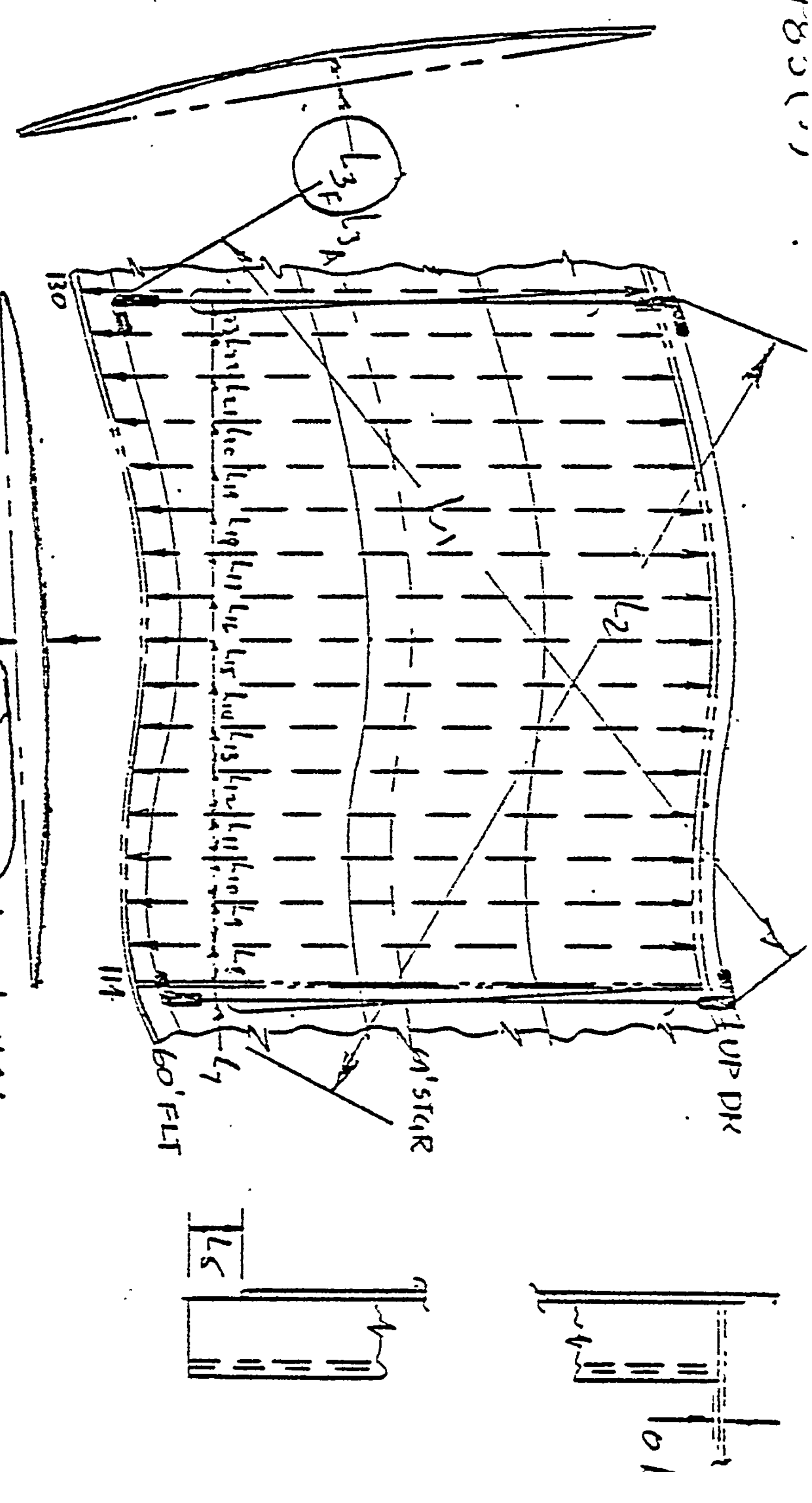
AP-2-3

AFTER WELDING

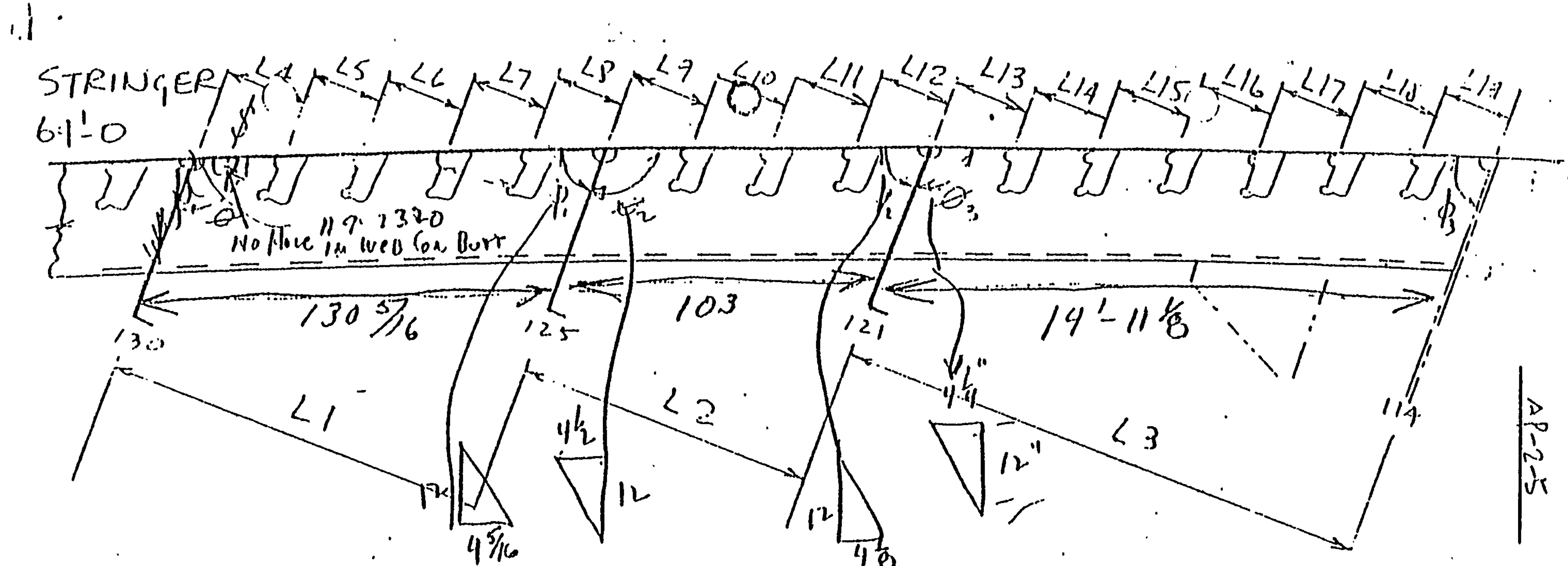


AD-2-4

DES DIM	ACT DIM	Δ DEV	Δ AL
COULD NOT MEASURE			
COULD NOT MEASURE			
$11\frac{5}{8}$"	$10\frac{5}{8}$"		
COULD NOT MEASURE			
3"	$2\frac{7}{8}$"		
COULD NOT MEASURE			
BEFORE WELDING	AFTER WELDING		



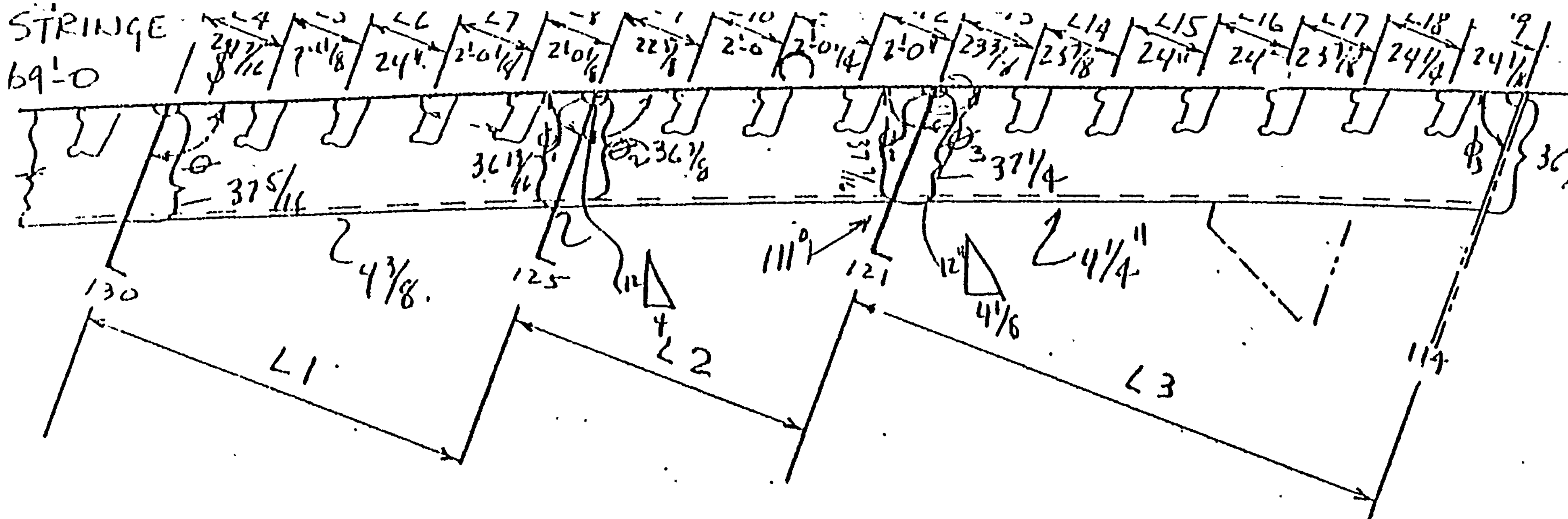
AP-2-5



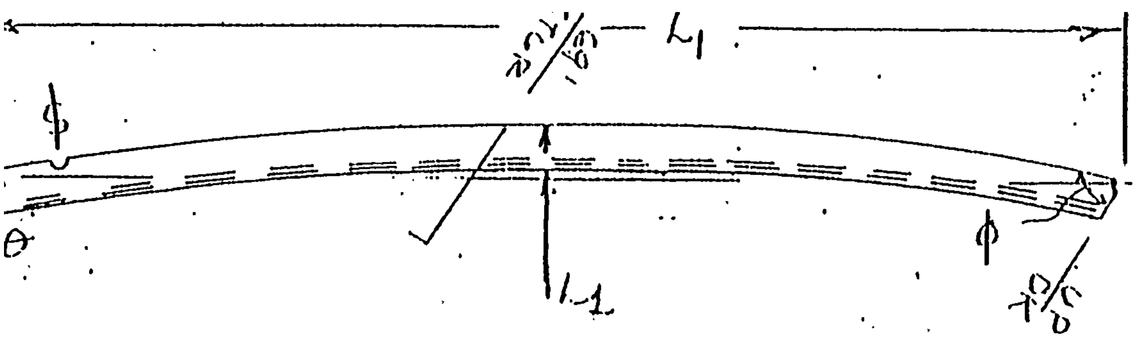
PART	L	DES DIM	ACT DIM	Δ DEV	Δ AL			L's		Act	REMARKS	
								L5		24"	L16	24 5/8
								L6		24 1/2	L17	24"
								L7		24 5/16	L18	24 3/16
								L8		24 3/16	~~L19~~	
								L9		23 5/8		
								L10		24 1/8		
								L11		24 7/16		
								L12		24 1/16		
								L13		23 7/16		

NOTE
DIMENSIONS AFTER
WELDING WAS COMPLETED

AP-2-6

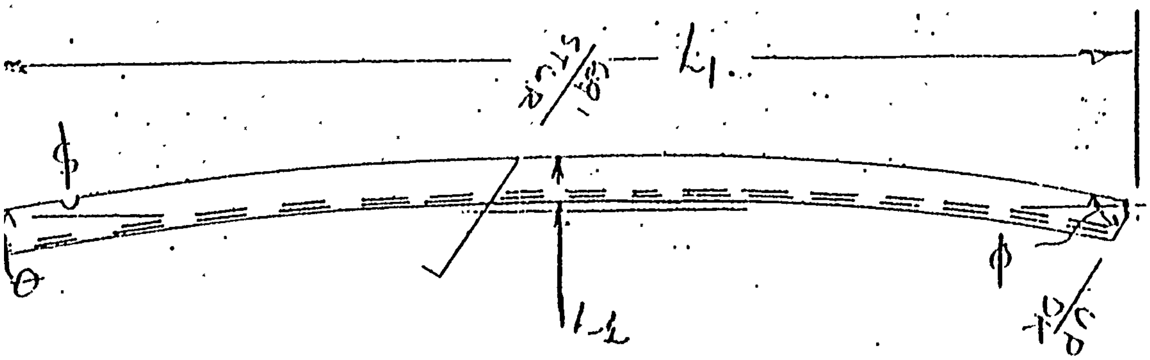


RT	L	DES DIM	ACT DIM	Δ DEV	Δ AL			REMARKS
	L_1	10'-10 1/2"	130 5/16					
	L_2	8'-6 3/4"	102 5/8					
	L_3	14'-10 3/8"	14'-11 1/8"					
	Θ_1	113 1/2°						
	Θ_2	112 1/2°	/					
	Θ_3	111°	111°					
	Φ_1	67 1/2°						
	Φ_2	69°						
	Φ_3	70°						
THRU		24" TYP	SEE ABOVE					



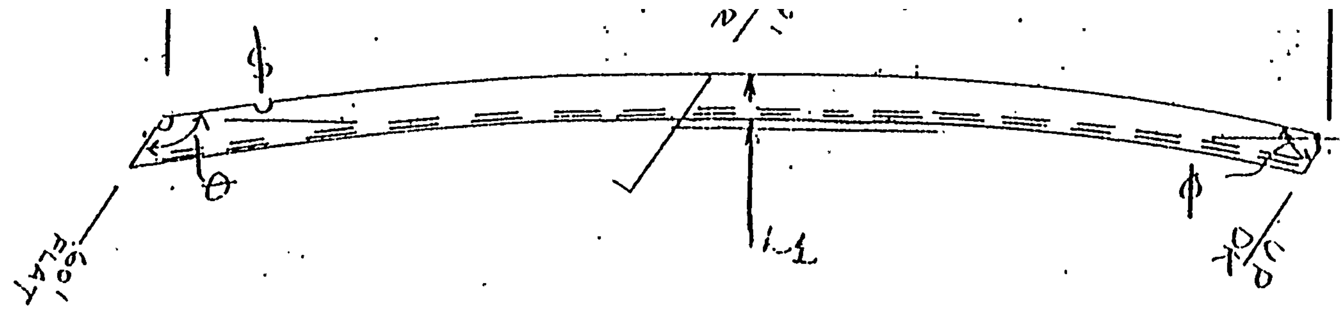
Δ EV	Δ AL	CHECKI INT	REMARKS

1



Δ DEV	Δ AL	CHECK INT	REMARKS

AP-2-9

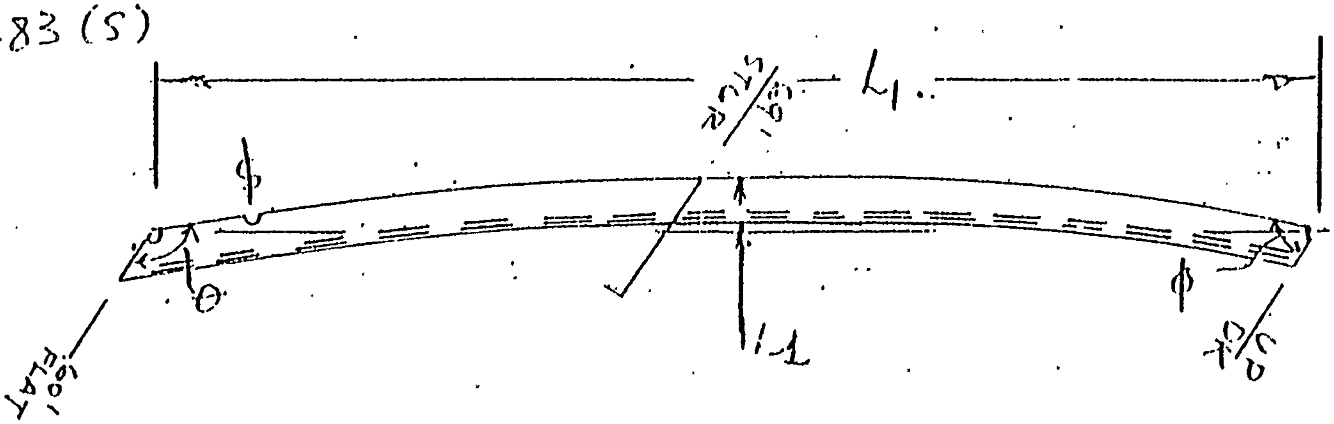


PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECK INT	REMARKS
11-2373	L_1	24'-4"	24'-4 1/8				
	L_2						
	θ	134	134 1/2				
	ϕ	68	69°				
11-2371	L_1	24'-6 1/4	24'-7"				
	L_2						
	θ	135	136°				
	ϕ	70	68 1/2				

ASSY A2-483 (S)
3RD FRAME

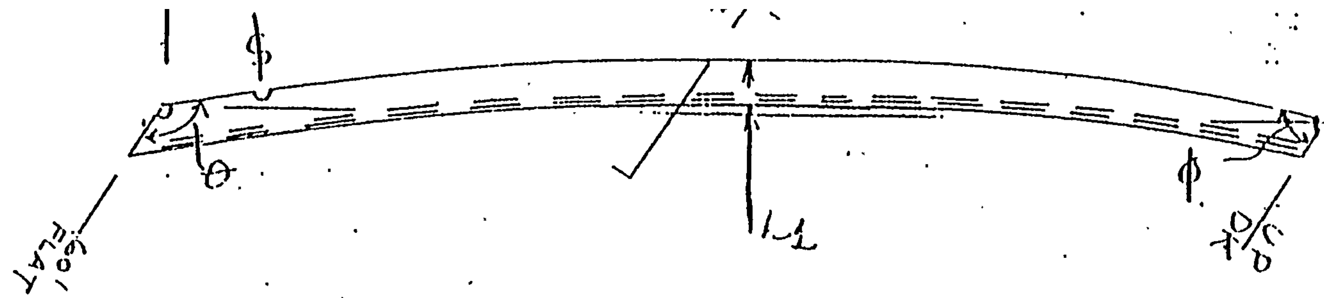
(1)

AP-2-10



PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKER INT	REMARKS
7-2377	L_1	24'-1 7/8	24'-3"				
	L_2						
	θ	133°	133 1/2				
	φ	70°	69°				
17-2375	L_1	24'-3 1/8	24'-3 5/8				
	L_2						
	θ	135	134 1/2				
	φ	69°	69°				

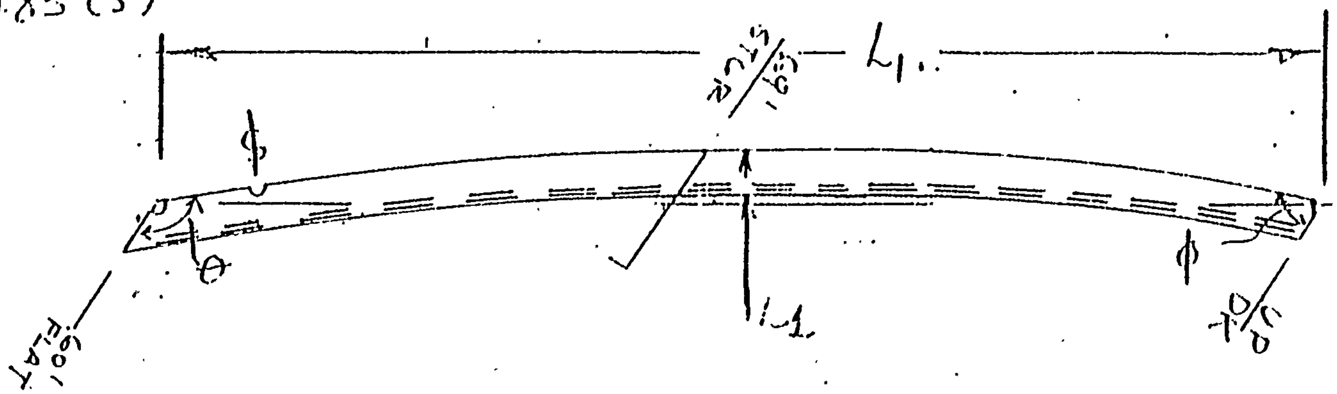
AP-2-11



PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKER INT	REMARKS
19-2381	L_1	23'-10 1/2	23'-10 7/8				
	L_2						
	θ	134	134				
	ϕ	69°	68°				
19-2379	L_1	23'-11 5/8	24'-0 1/8"				
	L_2						
	θ	133 1/2	134 1/2°				
	ϕ	70°	68°				

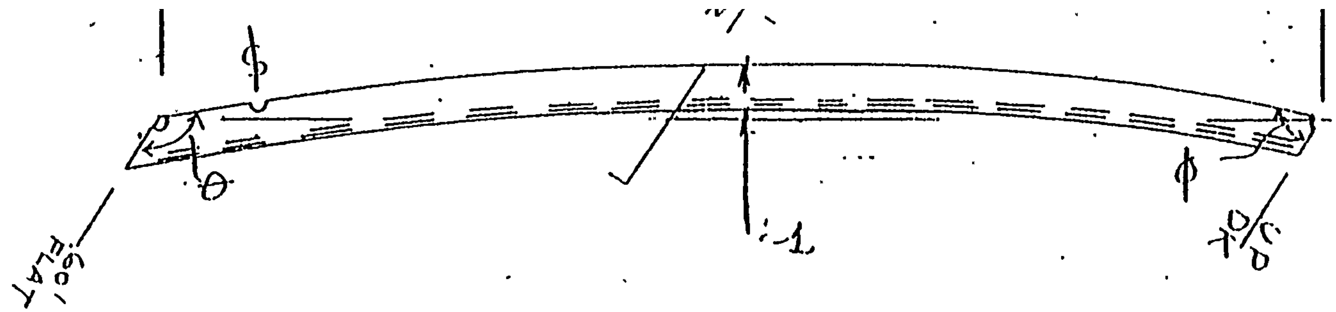
ASSY 12-483 (S)
3RD FRAME

AP-2-12



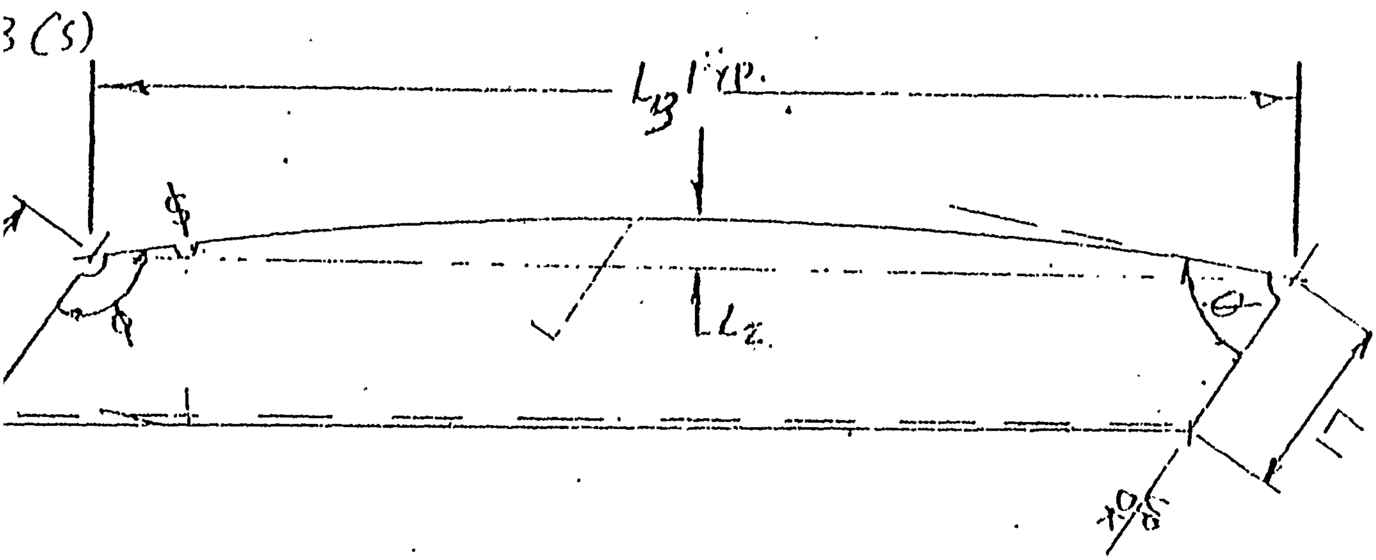
PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECK INT	REMARKS
11-2385	L_1	23'-8	23'-9¼				
	L_2						
	θ	132°	133°				
	φ	69½°	69°				
11-2393	L_1	23'-9⅜	23'-9¾				
	L_2						
	θ	131½	133°				
	φ	68½°	67½°				

AP-2-13



NOTE 1" XS

PART		DES DIM	ACT DIM	Δ DEV	Δ AL	CHECKER INT	REMARKS
17-2387	L_1	23'-6 3/16	23'-6 11/16"				
	L_2						
	θ	133°	133°				
	ϕ	70°	69°				
17-2387	L_1	23'-7"	23'-6 11/16				
	L_2						
	θ	134°	133°				
	ϕ	71°	69°				



CT M	Δ DEV	Δ AL	CHECKER INT	REMARKS
1/4				
1/8				
-0				
1°				
2 1/4				
9/16"				
5°				
1°				

STUDY REPORT ON SHIPBUILDING

FOR

NATIONAL STEEL AND SHIPBUILDING CO.

Volume III

- Palletization -

October, 1979

IHI

Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

CONTENTS

PAGE

CHAPTER I - CONCEPT OF PALLETIZATION

1. Overview of Palletization

Until approximately 20 years ago., machinery, -piping, ducts, electrical wires, handrails, ladders, manholes, furniture, and other items referred to as outfitting materials, would be installed onboard while a ship was in berth or at pier. The installation work was usually planned to be carried out system-by-system, and was started after hull construction was completed.

Ballast piping and firemain piping running through one compartment were scheduled separately. Two different groups of workers were engaged in those installations. The number of activities to be controlled for a ship was tremendous and its network was too complicated for satisfactory interface between the systems.

When the ballast piping system had a special connection with the firemain piping system, ballast piping workers whose work progressed more quickly than others, had to wait until the firemain piping installation progressed enough to allow connection.

AS the piping installations progressed system-by-system, the work area was scattered over the ship. While a group of workers was mounting a firemain valve on the foc'sle deck, others were installing steam piping on the upper deck, bilge piping in the hold and ballast piping in the double bottom tank.

A group who was going to install a bilge suction manifold might have to hold up work in order to escape from a shower of melted metal which was ejected by another group who were cutting pipe supports, located just over the bilge manifold. Such problems made 2 pipefitting foreman unable to keep track of the current status of his johs.

When-work was to be started, a worker who was in charge of material handling referred to the drawing and went to the warehouse to receive the necessary materials. However, many. times a valve was not provided in time because of a stock shortage. The pipefitter then had to fabricate a temporary spool piece to use in place of that valve. When he received the valve, he had to, return to the place where the spool piece was temporarily mounted, to replace it with the valve. This forced him to spend additional manhours in transferrig tools with heavy hoses from one area to another.

Every piece of pipe was brought into a compartent through many narrow doors and up and down steep ladders, and to the place where it was to be installed.

Sometimes piping had to be installed overhead in the Engine Room, where the installation was dangerous, but scaffolding was costly. Such an environment would hamper workers' skills and productivity

Today, methods of outfitting have changed notably- Most outfitting work is started and completed zone-by-zone. When looking at the complexity of outfitting jobs controlled system-by-system, an

outfitting planner thought that if he could divide his jobs by zone and complete them independently, job planning could become much easier.

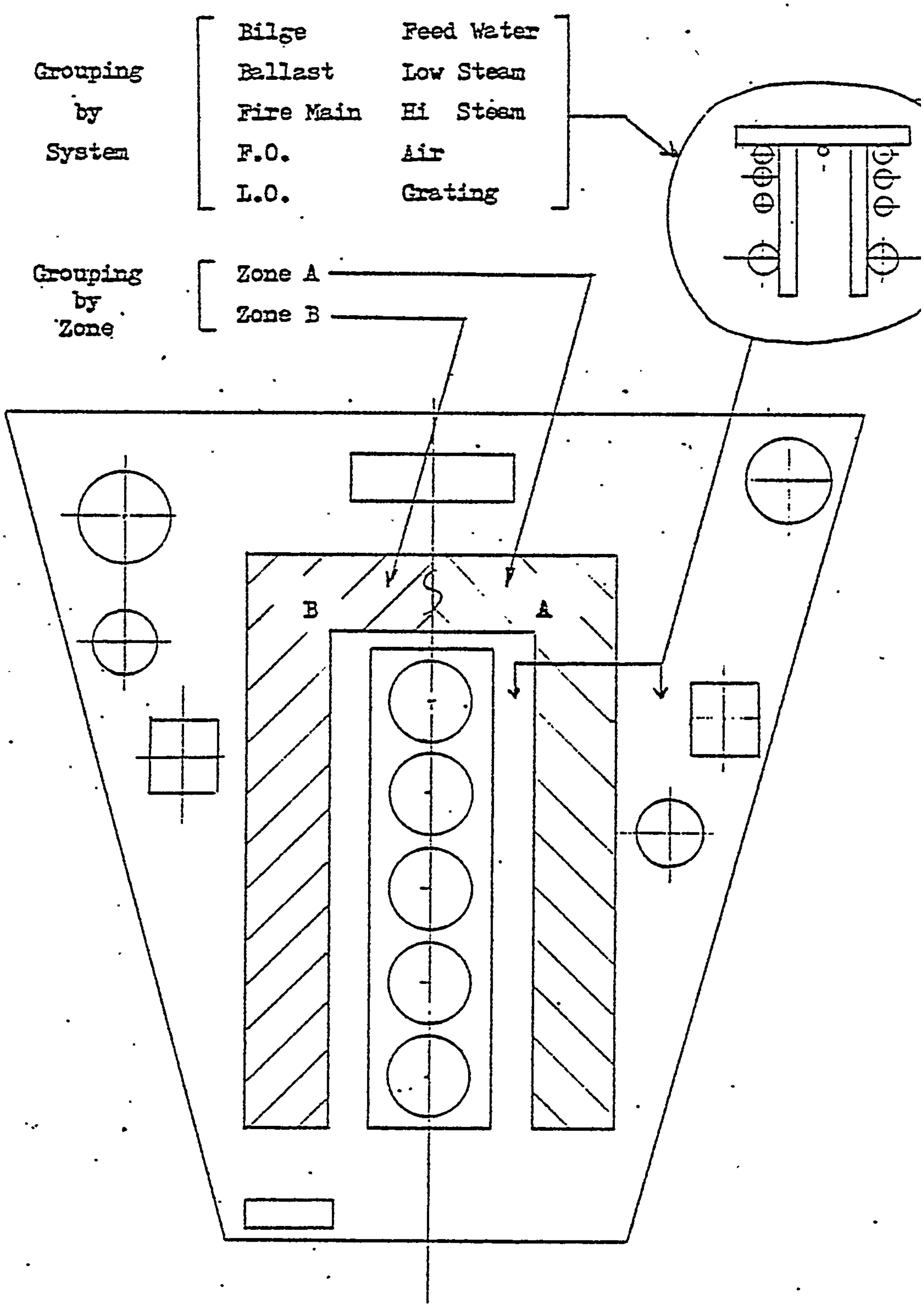
For example, if he had bilge, ballast: firemain, fuel oil, lubricating oil, feed water, low-pressure steam, high-pressure steam and pneumatic air piping running along the access passage, he had to take into account at least 10 elements when scheduling work system-by-system.'

However, if they can be divided into 2 zones and completed independently, the number of activities can be reduced from 10 to 2. (See Fig. l-1.)

To begin with, he drew several lines on the upper deck (for example, one centerline and several transverse bulkheads), creating areas within those lines. He called these areas "work zones." He grouped all materials which were to be installed in one "work zone" in the following manner:

<u>Group A</u> (material for pipefitters)

3 straight pipes, 1 bent pipe with branch, 1 stop valve and 1 penetration piece for ballast piping, 2 straight pipes, 1 straight pipe with branch, 4 fire hose valves and their maniholds for firemain piping, 4 pipe supports commonly used for ballast and firemain pipes, bolts and nuts for pipe support, bolts, nuts and packing for pipe joint.



Grouping by System
Bilge
Ballast
Fire Main
F.O.
L.O.
Feed Water
Low Steam
Hi Steam
Air
Grating
Grouping by Zone
Zone A
Zone B
B
A

Fig. 1-1

Group B (material for outfitters)

2 manholes, 2 length of handrails, 1 bollard, 1 grating installed over pipes.'

Looking at these material groups, he considered that durations (or manhours) for installation of those grouped materials had to be suitable for control and that the number of activities bad to be neither too many nor too few. He thought that appropriate unit activity would be one week in duration on the average and that it would correspond to approximately 30-40 pieces of pipes in- the case of pipefitting.

Also he considered that if 1 penetration piece of Group A and 2 manholes of Group B could be installed during the assembly stage of hull structure, he could save Additional, compared with having to install all materials onboard. In that way, workers could be in fresh open air, safe conditions, favorable access conditions, tool availability, and so on. He then decided that those were to be another group, and named it A2. Finally, he settled his groups into Groups Al, A2, B1 and B2 for the particular "work zone."

He also thought that if it were possible that the installation jobs for Groups Al., A2, B1 and B2 were individually accomplished by one worker group of a single trade and at one time. If all of his ideas were possible, it would give him a means of job control. He then called each single unit of installation jobs an "Activity."

Today, he schedules all of his outfitting jobs by "Activity" such as Activity A1, A2, B1 and B2. As he has-studied, Activities A1 and B1 will be scheduled for the onboard stage and Activities.A2 and B2 for the assembly *stage* of hull structure. Of course, he is aware that he needs a new activity which has no materials belonging to it, such *as* adjusting gauges, hydraulic testing, operations, etc.

Now, all materials of Group A are packed in steel containers and lined up at the front of the warehouse when the Group A scheduled issue date arrives. The warehouseman calls them "pallets." The pallet has a small pocket where a material list is attached. From the material list, not only the warehouseman, but also the pipefitter and enyone else who wants to know can understand the following:

What materials should be contained in this pallet What materials are actually contained? What material are missing because of delayed shipment? Where are the materials in this pallet *to* be usedd for? Where is this pallet to be delivered? When is this pallet to be delivered? What stage does this pallet go to? What trade is in charge of this pallet?

When a foreman is to start an activity, all he has to do is to tell the warehouseman the pallet number corresponding co the . activity. (Number of activity and pallet are the same.) The warehouseman then sends the pallet to its own destination.

When pipefitters go to the ship (work zone) as their foreman indicates they will find all of the necessary materials (pipes, valves,

bolts, nuts and gaskets); delivered to the work area. All they have to do is to install materials within a limited area as indicated in the drawing. Connections between different piping systems must be completed as soon as all work in one work zone is completed.

Now activities are scheduled in a workable order. Work is completed zone-by~zone and is not stretched widely. Consequently, the foreman can easily see his job situation. This gives him a flexible operation.

He has now established from experience the advantages for getting more profit on his job by palletizing.in process, .such as:

- One.pallet has- to :include all-materials necessary to complete one unit of work. One unit of work means one activity in his network.or one arrow line in his schedule chart (one control unit)

- One pallet has to include all materials shown in one pallet zone on the composite drawing. But materials in one pallet may be divided into some partitions for each working stage, if necessary. "All materials" means not only major materials but also minor matetials as pipe supports, bolts, nuts, gaskets, etc.

- Technical information for improvement on the job has to be fed back to the designer as precisely and quickly as possible so

as to be reflected on the piping design at once. One of the important features included in technical documentation is installation practices, such as installation sequence, location of loose pipe, loose flanges, parts to be preassembled, production stages at which materials are installed, etc.

6 Area or subdivision of pallet zone must be suitable supervised.

He then asks the question, What groups and/or workers could best utilize palletization?” His reasoning is based on the following:

When the system-by-system process was used, he thought that every particular system required its own special technique **or** skill. But when pieces of pipe in one pallet are complete set for piping system in a certain *area* consisting of completed parts (spool piece), all built with particular features required by a particular system, then special techniques skills will not be required:

For example, if high-pressure steam piping is delivered with special copper gaskets, special strong bolt-nuts, special spring hangers, etc., and each of them is identified as to location by referring to a drawing, and that drawing indicates all necessary information for installation such as distances between the pieces and frame lines, height from deck, whether the piece has to be installed permanently or temporarily, whether a flange of the piece has to be “loose” or not, *etc.,* then the piping installation no longer requires particular techniques and skills.

Instead, if a production-oriented zone-by-zone drawing is utilized, the installation becomes simple, such as only putting the pipe piece on a line as indicated in a drawing, tightening flanges after inserting gaskets *which are* delivered with the pipe piece, welding hangers, and so on. He reaches the same conclusion in regard to all other outfitting" materials.

This reasoning suggests a possibility of improving the efficiency of workers' trade in that only one group of workers (in special *cases,* only one worker) can accomplish a single activity.

He can now plan an education program for multi-trade workers, the workers who are capable of installing piping, gratings, manholes," bollards, machinery, etc. He concludes that this is a way of attaining higher productivity from the viewpoint of schedule control and of providtin greater satisfaction *for* the workers.

Figs. 1-2 and 1-3 illustrate general view co emphasize the difference between outfitting by system and by zone. The former has a trend that materials are loaded and installed piece by piece - inefficiently, while materials of the-latter *are* loaded and installed in group - efficiently. The difference in efficiency is mainly brought from careful planning by means of zone.

Fig. l-4 shows machinery and pipes installed by zone on the block before block loading to the due position in the building dock. Fig. 1-5 shows ducts, pipes and other fittings right below a ceiling of an accommodation space which are being installed by zone on the turned over block before erection.

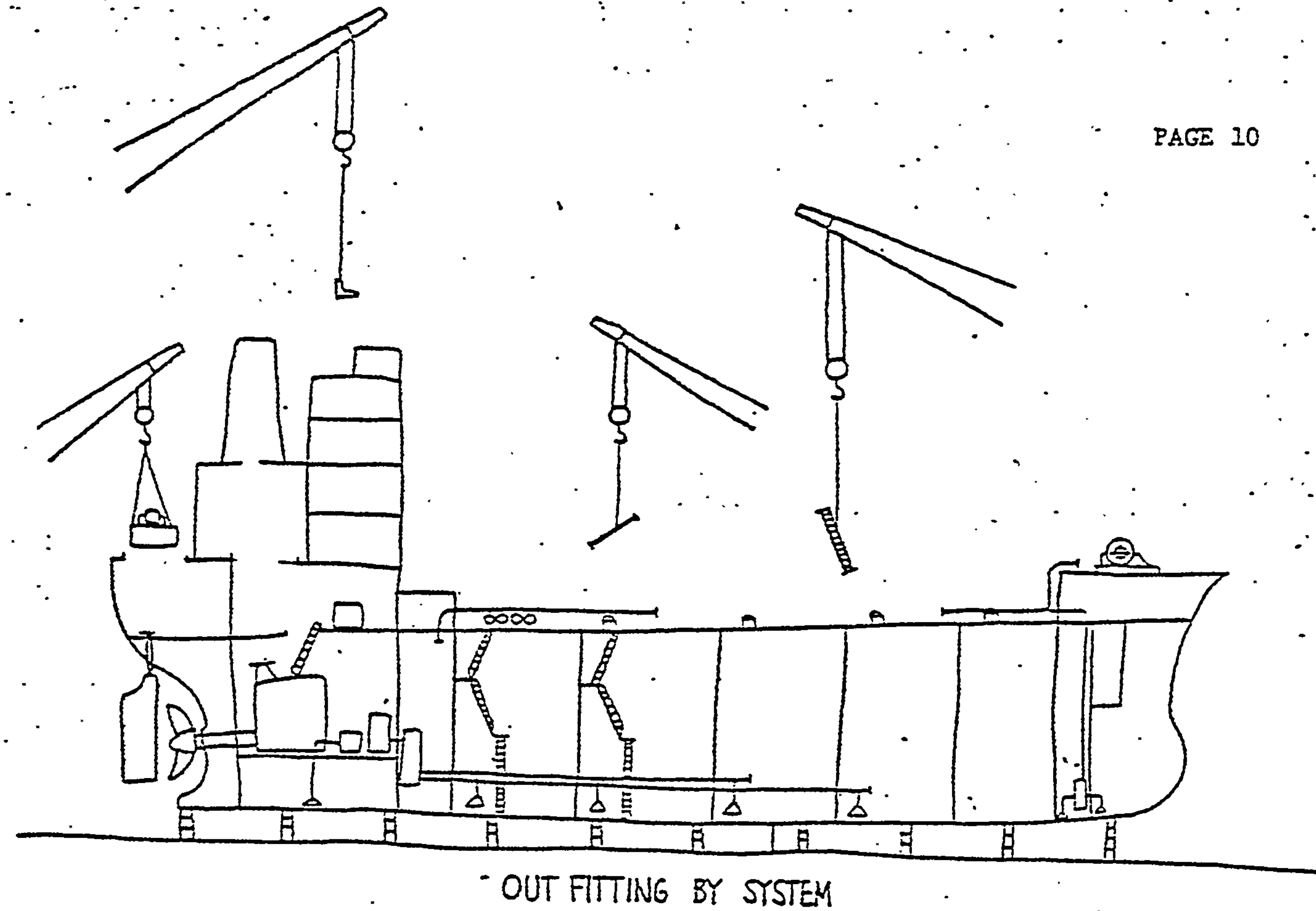


Fig. 1-2

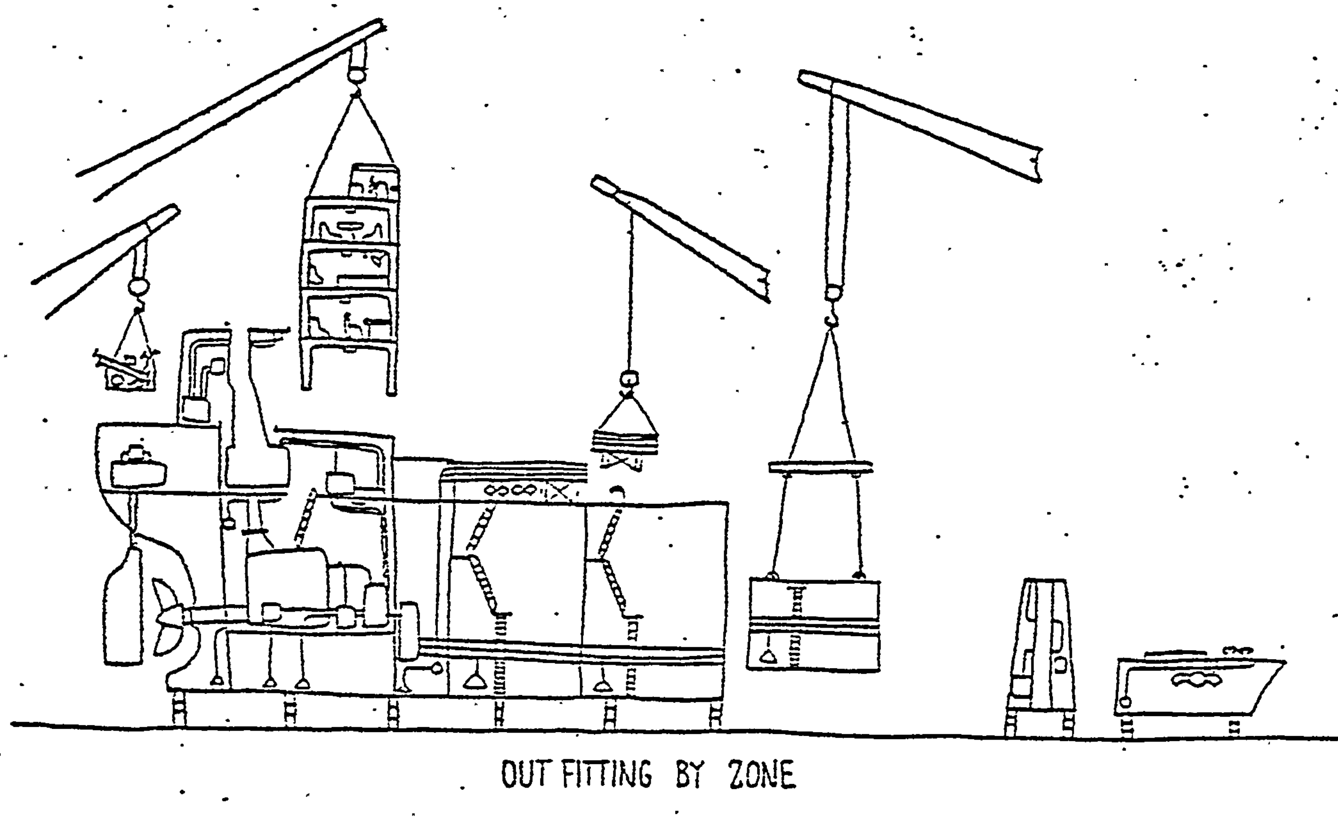


Fig. 1-3

Fig. 1-4

Erection of grand block outfitted before erection

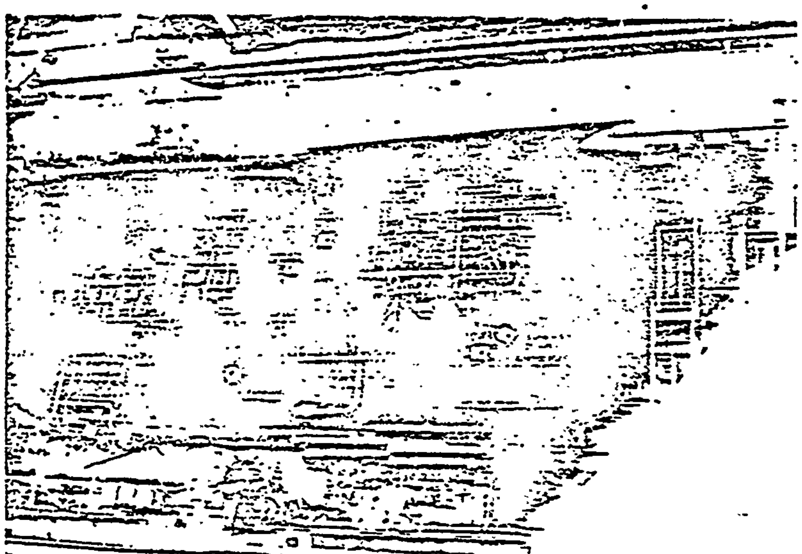


Fig. 1-5

On-block outfitting

2. Concept of Palletization

2.1 Introduction

When we consider the efficiency of outfitting, it may be necessary to return to the substantial nature of shipbuilding; the main activity is. *"Assembly,"* dealing with and fitting various kinds of materials.

Such a variety of materials means depending generally on the labor-force to perform installation or fitting in a *large* physical area and by prolonging the working period. That also means working-with many kinds of jobs, at the same area, in some orderly *manner."* The weights of *all* materials range from the heaviest, which is lifted by machinery, to the lightest, which is carried by hand. These methods may produce idle time. This is the essential point to be *taken* into account when considering the efficiency of outfitting.

In summary, every material of some 50,000 items in a ship goes through several fabrication processes: as to *raw material*, from the purchased time until manufactured and fitted onboard; as to finished product, from the purchased time until fitted and tested. Until a ship is completed, we can assume that there are some 500,000 processes. Only one hour of idle time on one process means some 500,000 hours of idle time in all.

This idea leads one to consider whether it is possible to reduce the idle time by reducing the number of processes when dealing with many materials at the same time. The idle time between processes is reduced accordingly in amounts down to 10,000 hours, provided some 50 processes are dealt with as a process.

The idea of fundamental demand for palletizing is described here in part.

2.2 The Aims of Palletizing

1) To control the material flow starting with designing or production planning to fitting on the spot and to make it a unit of the flow.

2) To control the manhour flow in production and to make it a *unit* determined by the flow.

These two main aims can be broken down as follows:

1) To be aware of the jobs of one pallet as the unit of a job, and to make the job itself highly qualitative and highly efficient.

2) To regard the unit of a job as *a* process, to optimize the process flow and to simplify scheduling.

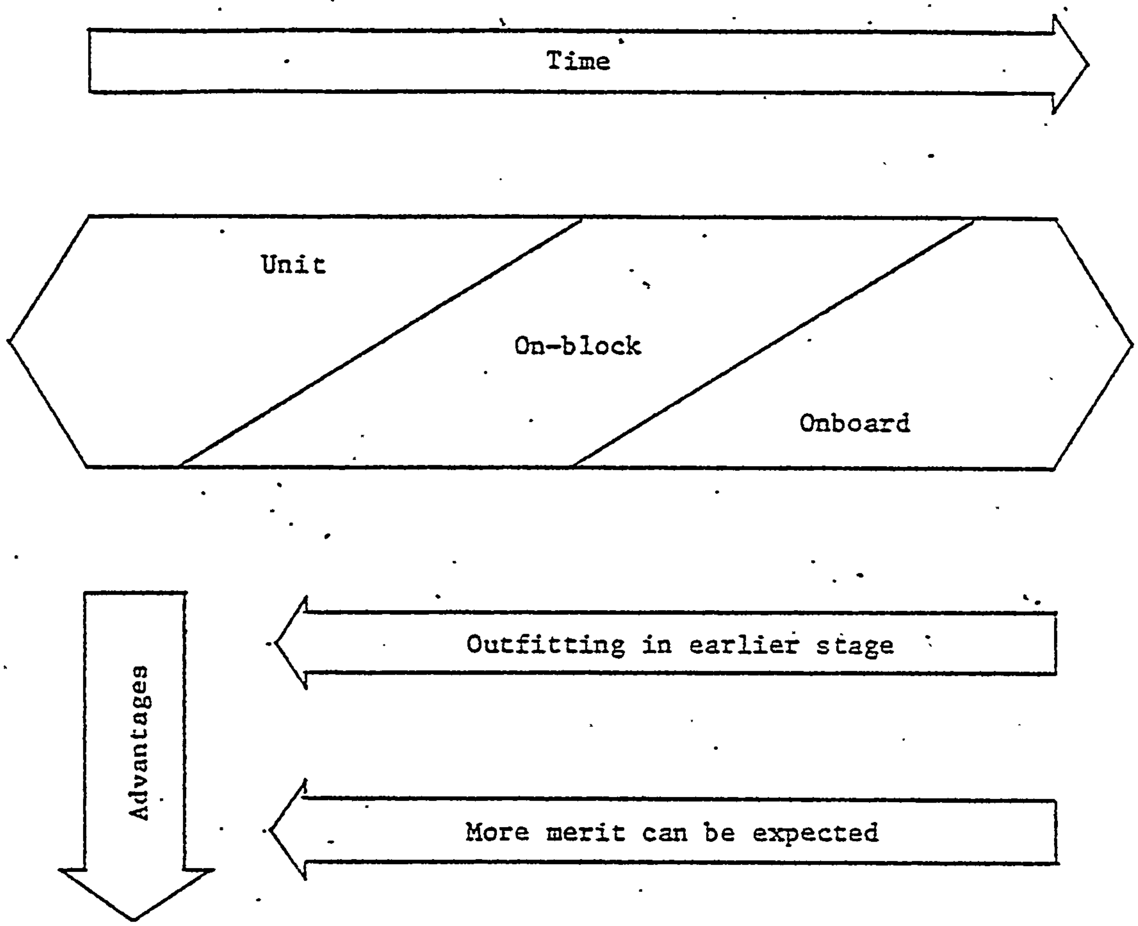
3) To regard all material as a part of the whole ship rather than as a part of each system; in other words, to make it nonfunctional or physical through the development of composite drawings in design.

4) To be aware of the pallet as a unit of material procurement control which starts with the design department's specifying the materials, thus making it a unit or a base, of drawing issue control.

It is not necessary to explain the above aims in great detail as *they* only refer to the most important aspect of the design. Even if palletizing without design is provided, it is essential to plan for palletizing. What kinds of materials are grouped? How do we get these materials in time as *a* whole? The design intention, actual drawing and the material specification lists are necessary to answer such questions. The progress of planning for palletizing is based on the development of the design, so that development of the drawing, the drawing issue schedule, and the list of materials are developed in a fashion to support the palletization concept.

properly speaking, design in relation to the drawing and the material specifications is the starting point of material flow *Of* production. Briefly stated, the ai m of palletizing . is to make the flow of men and materials in the factory systematic from design through production.

ADVANTAGE OF PALLETIZATION



1. To minimize work onboard (low-efficiency work) and to increase work in shop (high-efficiency work).

2. To complete work zone-by-zone in order to make control easy.

3. To avoid trouble with hull construction and its work process.

4. To shorten total outfitting work period.

5. To improve efficiency of jumbo-sized facilities of berth/dock and shop.

Fig. 1-6

2.3 The Relationship of Palletizng, pre-Outfitting and Onboard Outfitting

The aims of palletizing are to provide --- materials for on-board outfitting as well as for pre- outfitting (= pre-erection outfitting). Although the merits of pre-outfitting are independent of the philosophy of palletizing, pursuing the merits of pre-outfitting will lead to palletitiing.

In pre-outfitting, a certain regional unit will be specified; for example, compartment or zone of a ship, some group of fittings surrounding a certain machinery, or some group of tubings. In palletizing, such a regional unit may be further divided into sub-regions from the viewpoint of job procedure and functionally separate stages.

Thus the unit of palletizing can be determined with only the intention of optinimizing of the job itself, whether it may be either pre-outfitting or onboard ourfitting. This important feature shows that, conversely speaking, planning for palletizing is indispensable for both pre-outfitting and on-board outfitting.

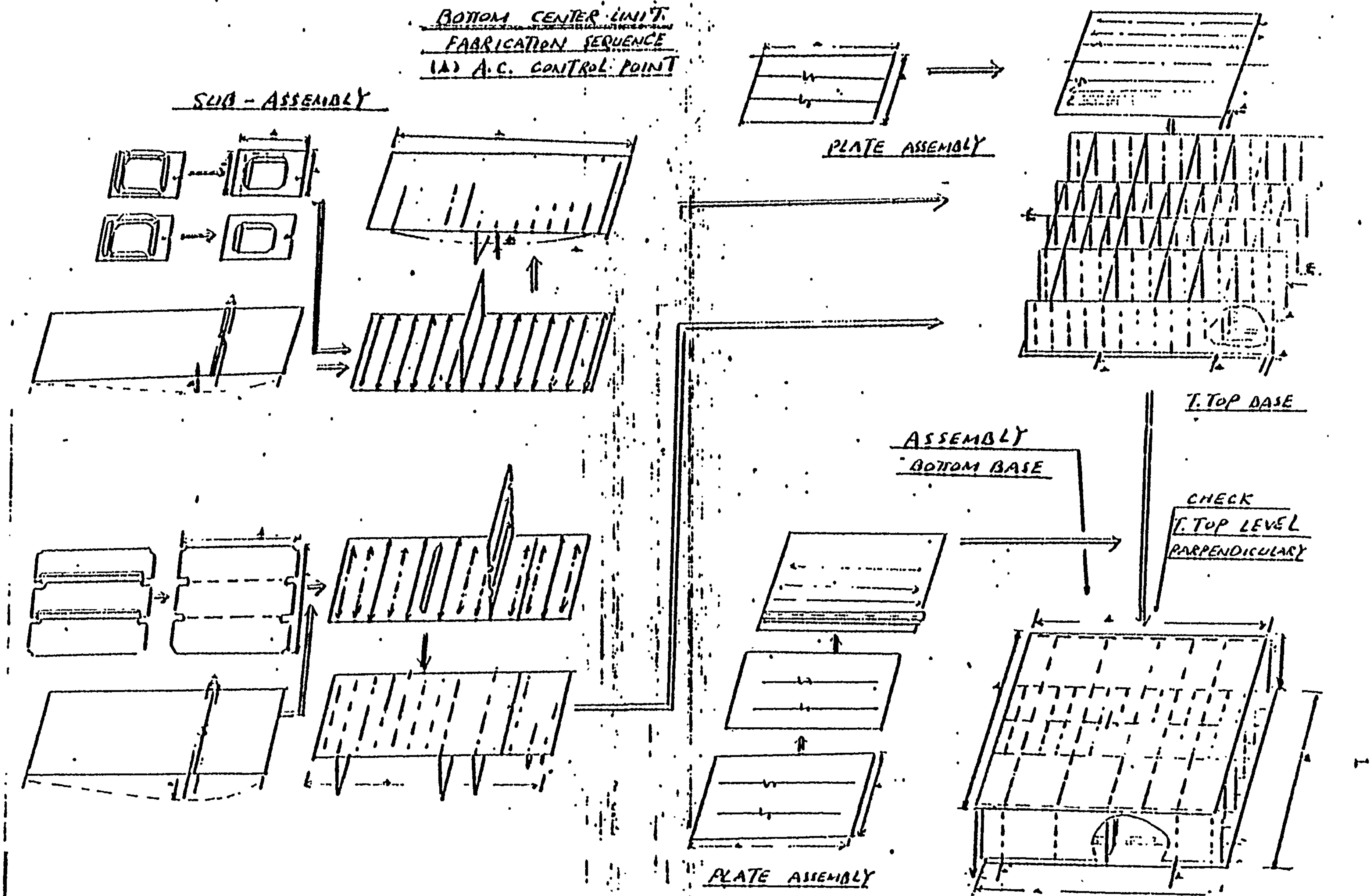
2.4 Grouping if Jobs

As we discussed, there are many elemental-jobs in the out-fitting field. Thet join together to form a network which is a powerful tool in outfitting job control. But the scope of the elemental jobs is too great to be controlled well, and must be reduced.

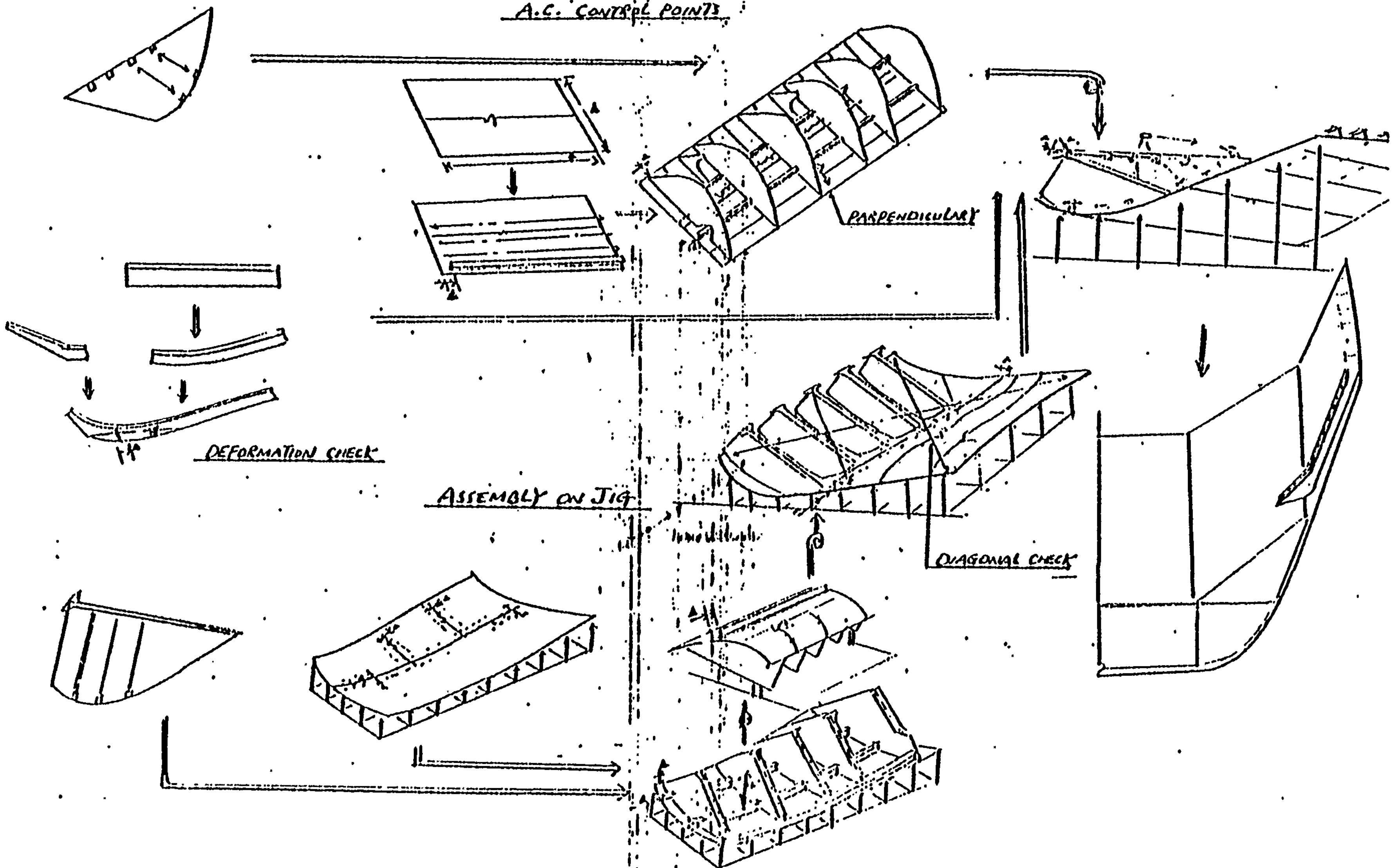
ACCURACY CONTROL

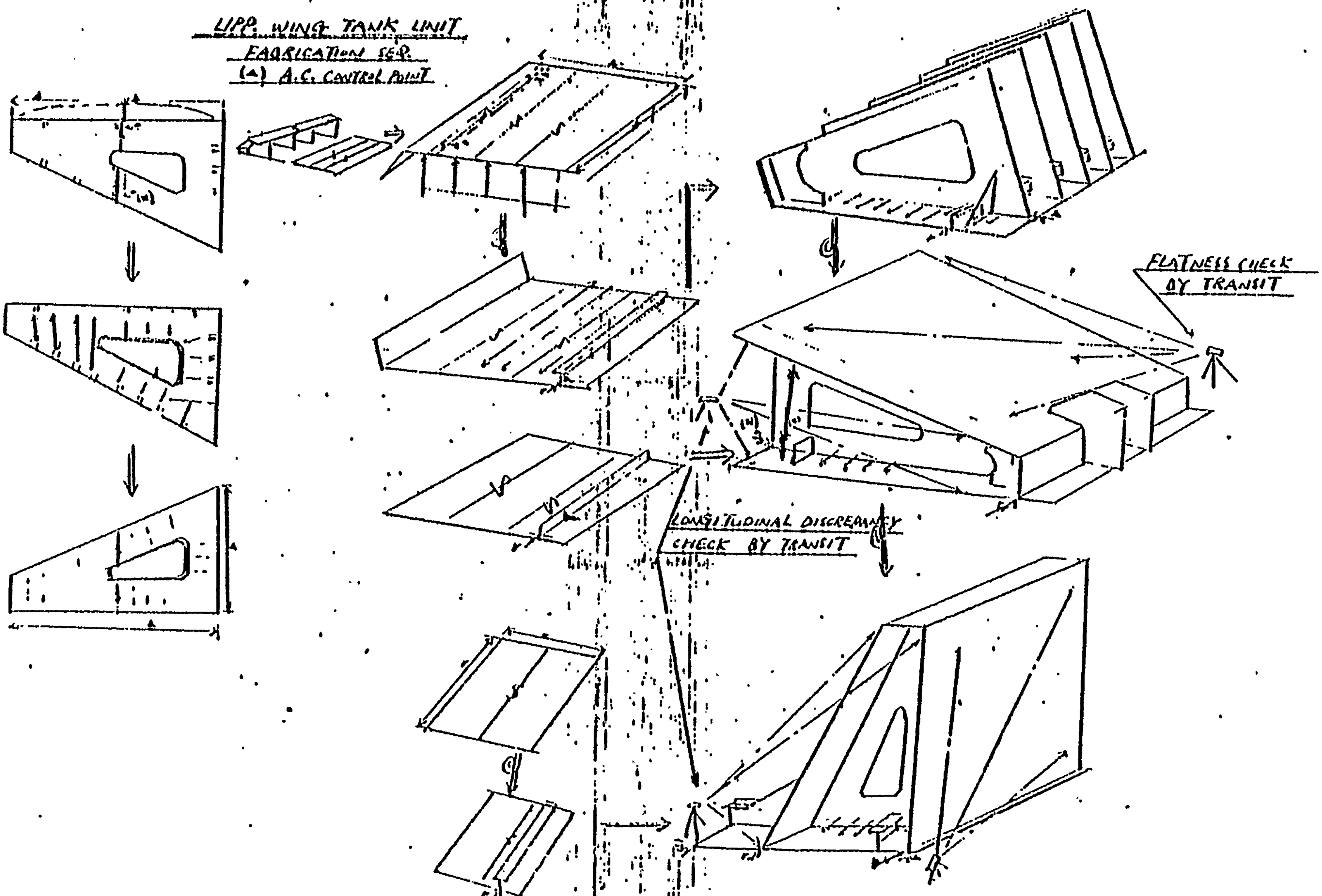
CHECK POINT, CHECKING DIMENSION, CHECKING METHOD
AT SUB-ASSEMBLY AND ASSEMBLY
BASED ON THE FABRICATION SEQUENCE OF A UNIT

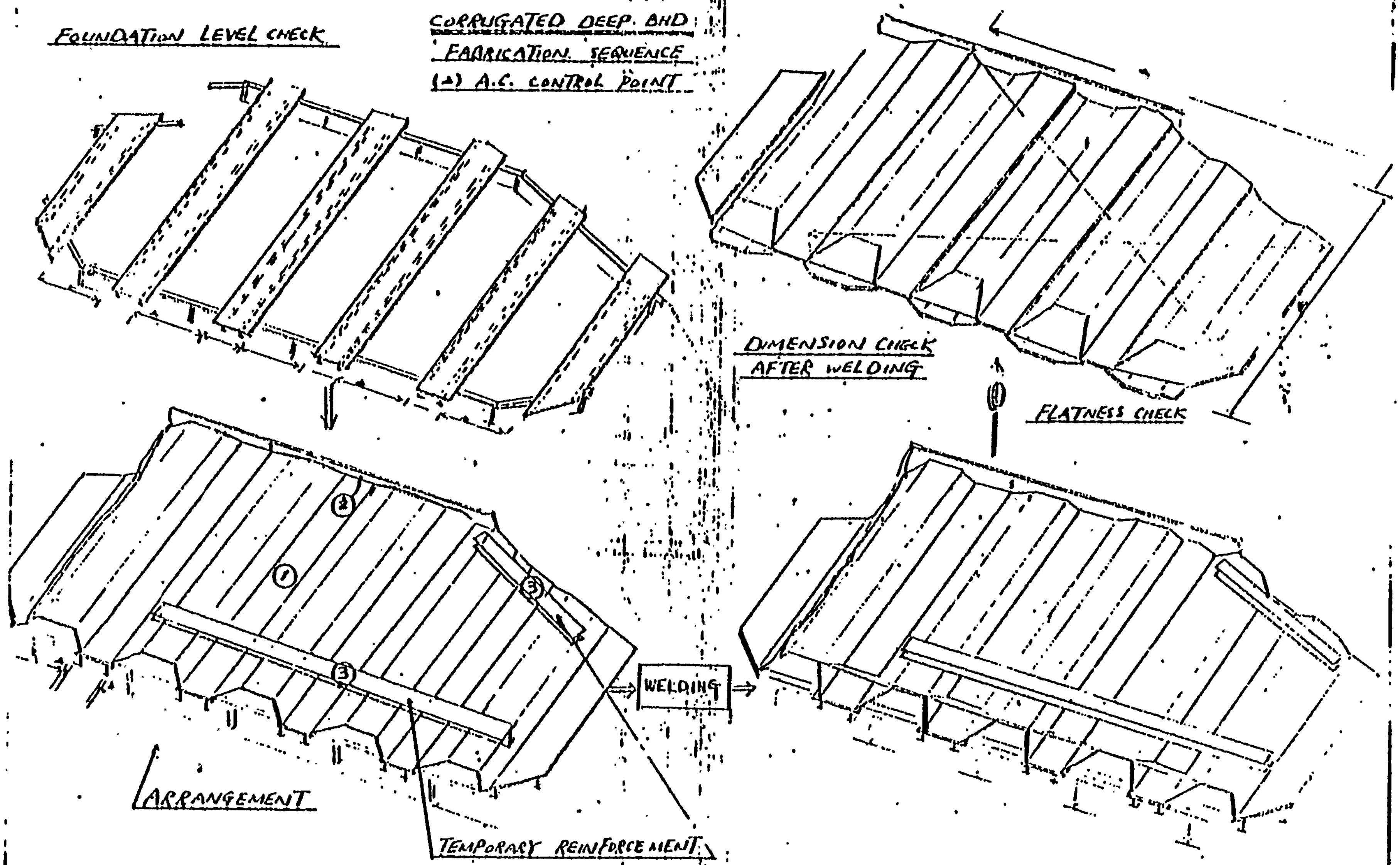
PREPARED BY IHI


BOTTOM CENTER UNIT
FABRICATION SEQUENCE
(A) A.C. CONTROL POINT
SUB - ASSEMBLY
PLATE ASSEMBLY
T. TOP BASE
ASSEMBLY
BOTTOM BASE
CHECK
T. TOP LEVEL
PARPENDICULARY
PLATE ASSEMBLY

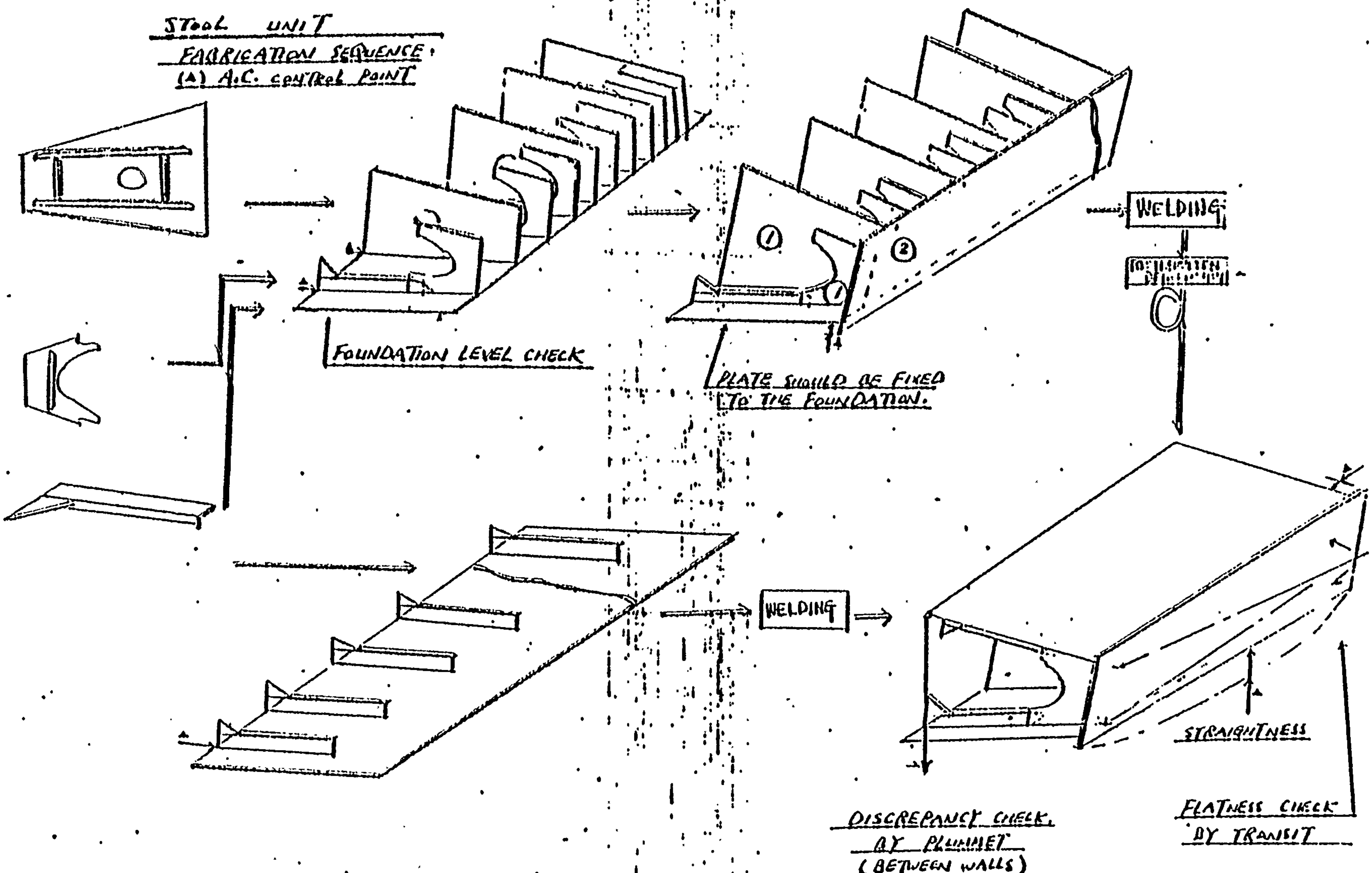
BILGE SHELL UNIT (CURVED)
FABRICATION SEQUENCE
A.C. CONTROL POINTS

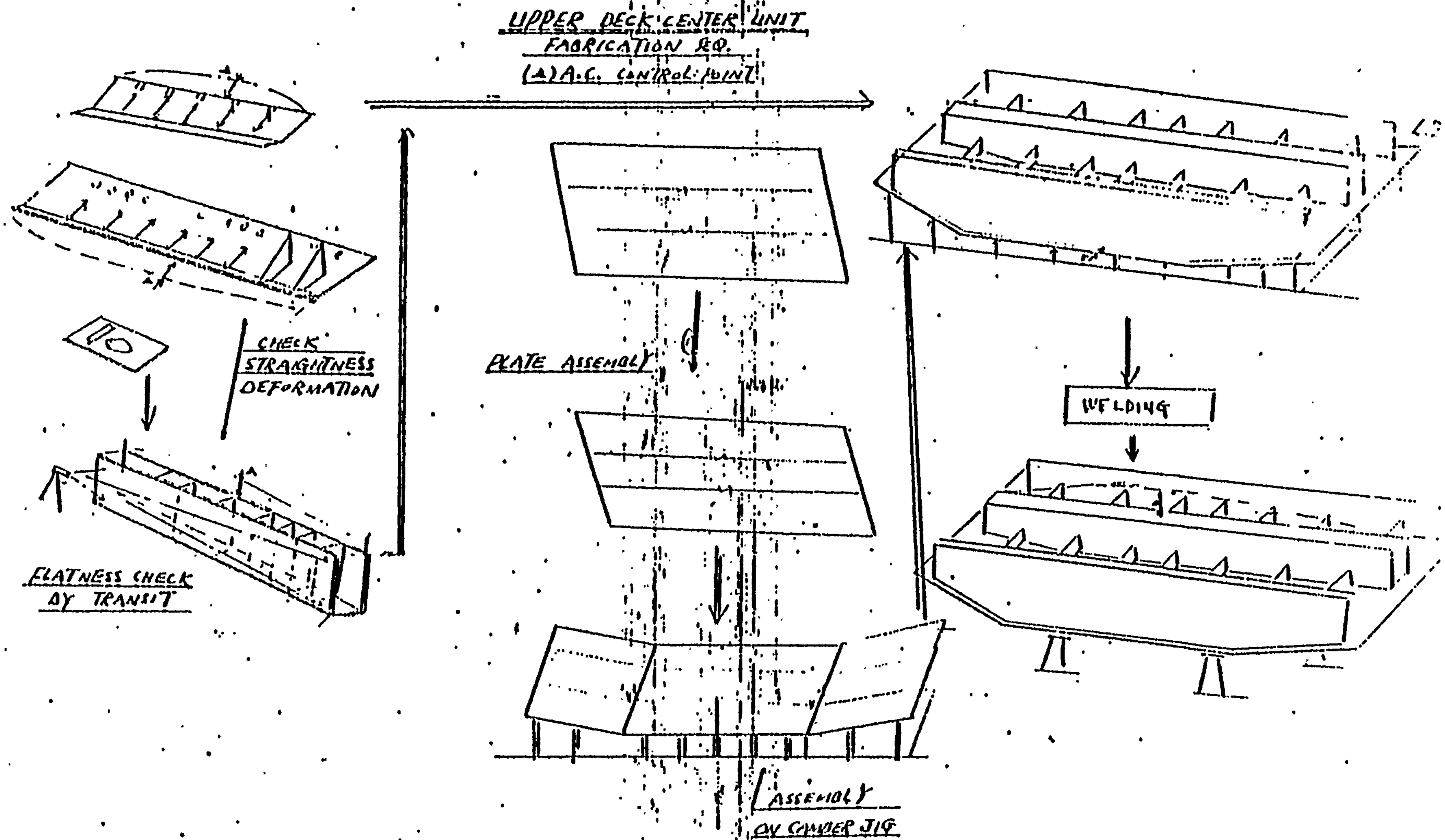



UPP. WING TANK UNIT
FABRICATION SEQ.
(▲) A.C. CONTROL POINT
FLATNESS CHECK
BY TRANSIT
LONGITUDINAL DISCREPANCY
CHECK BY TRANSIT



CORRUGATED DEEP. BHD
FABRICATION SEQUENCE
(▲) A.C. CONTROL POINT
FOUNDATION LEVEL CHECK
DIMENSION CHECK
AFTER WELDING
FLATNESS CHECK
ARRANGEMENT
WELDING
TEMPORARY REINFORCEMENT


STOOL UNIT
FABRICATION SEQUENCE
(A) A.C. CONTROL POINT
FOUNDATION LEVEL CHECK
1
2
PLATE SHOULD BE FIXED TO THE FOUNDATION.
WELDING
WELDING
STRAIGHTNESS
DISCREPANCY CHECK BY PLUMMET (BETWEEN WALLS)
FLATNESS CHECK BY TRANSIT


UPPER DECK CENTER UNIT
FABRICATION SEQ.
(A) A.C. CONTROL POINT
CHECK
STRAIGHTNESS
DEFORMATION
FLATNESS CHECK
BY TRANSIT
PLATE ASSEMBLY
WELDING
ASSEMBLY
ON CAMBER JIG

8

ACCURACY CONTROL

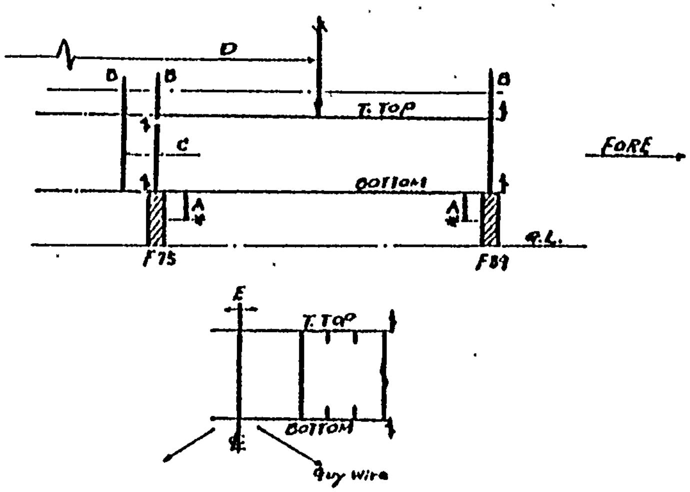
CHECK POINT, CHECKING DIMENSIONS, CHECKING METHOD

AT ERECTION

BASED ON ERECTION SEQUENCE

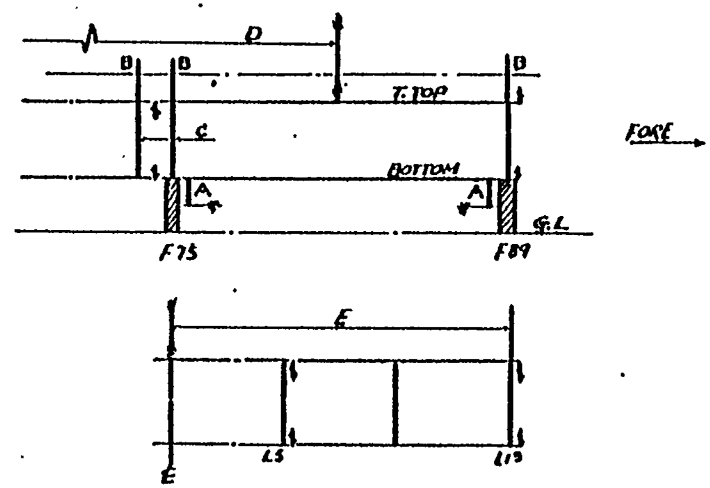
PREPARED BY IHI

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BOTT. CENTER



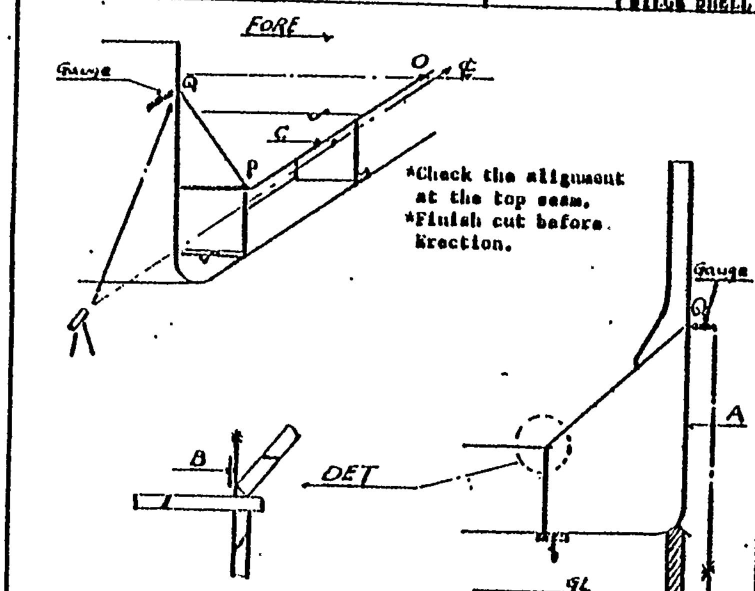
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at C.GIR by special gauge
B	Level			Worker AC	Measure at 4 corner points by Transit
C	Space Check			Worker	Measure by ruler
D	Space Check from Bhd. to Bhd.			Worker AC	Measure by ruler
E	Center line check			Worker AC	Adjust at fore end by guy wire. Measure by Transit

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BOTT. SIDE



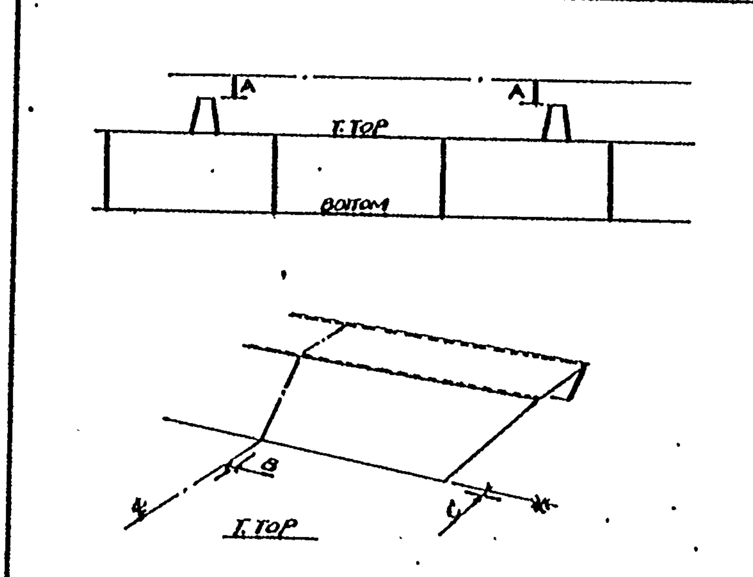
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Bottom Height			Worker	Measure at L13 by special gauge.
B	Level			Worker AC	Measure at 4 corner points by Transit.
C	Space Check			Worker	Measure by ruler.
D	Space check from Bhd. to Bhd.			Worker AC	Measure by ruler.
E	Width from C. line to L13.			Worker	Measure at fore & aft end by transit.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				BILGE SHELL



MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Width ℄ Perpendiculary			Worker AC	Read the gauge at "Q" by transit
B	Alignment & Gap			Worker	Check discrepancy from marked line.
C	Alignment at fore butt			Worker AC	Measure at 3 points (O.P.Q.) by Transit.
D	Alignment at the position of Bhd.			Worker	

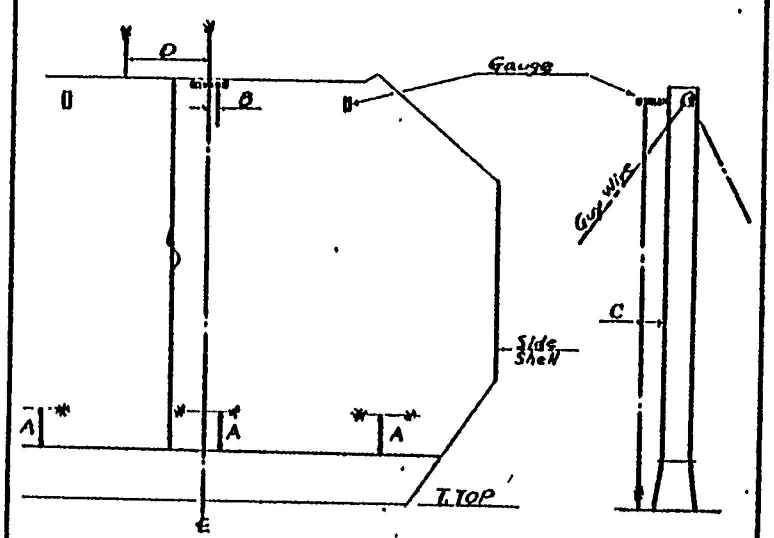
HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				STOOL



MARK	DESCRIPTION	DIMENSIONS	TOLERANCE	CHARGE	NOTICE
A	Level & Height			Worker AC.	Check of the level at the stool top
B	Center line			Worker	Check discrepancy from marked line.
C	Alignment of frame			" "	Do
D					

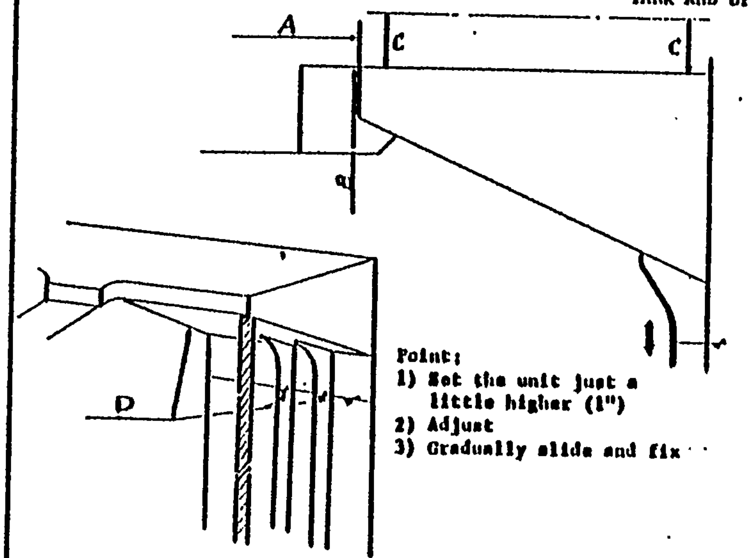
The unit is most vital to keep precise level and height of Bhd. and Upper deck.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				CORR. BHD.



MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Height			Worker	Check at marked line in final assembly
B	Center line			Worker AC	Measure at center line by transit
C	Perpendiculary check			Worker AC	Reading gauge by transit.
D	Width			Worker	Measure the dimension between 2 marked lines.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. WING TANK AND UPP DK. SIDE

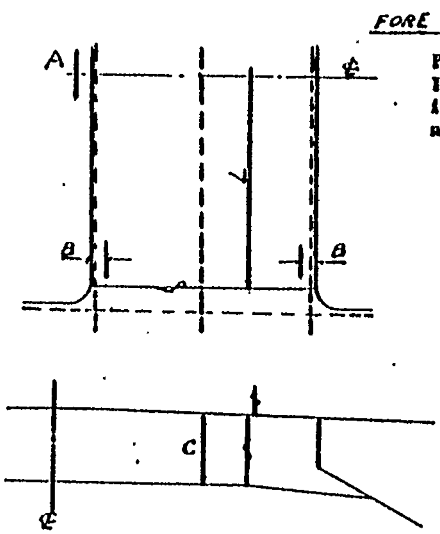


Point:
1) Set the unit just a little higher (1")
2) Adjust
3) Gradually slide and fix

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Width			Worker AC	Measure from center line by ruler
B	Height			Worker AC	Measure from T. Top by ruler.
C	Level			Worker AC	Measure at 4 corner points.
D	Alignment at each frame			Worker	

Inserted Unit: . Before inserting, the length between units (inserted space) should be checked and finish cut. Inserted unit should be neat cut at final assembly.

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT
				UPP. DK. CENTER



Point:
In case of the unit to be inserted: Check "L" and neat cut. (at Assembly)

MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A	Center line			Worker AC	Check discrepancy by transit
B	Alignment of the joining part			Worker	
C	Height			Worker	Before erection, check the dimension and neat cut
D					

HULL NO.	UNIT	ERECTION SEQ.	WEIGHT (T)	SHIPWRIGHT

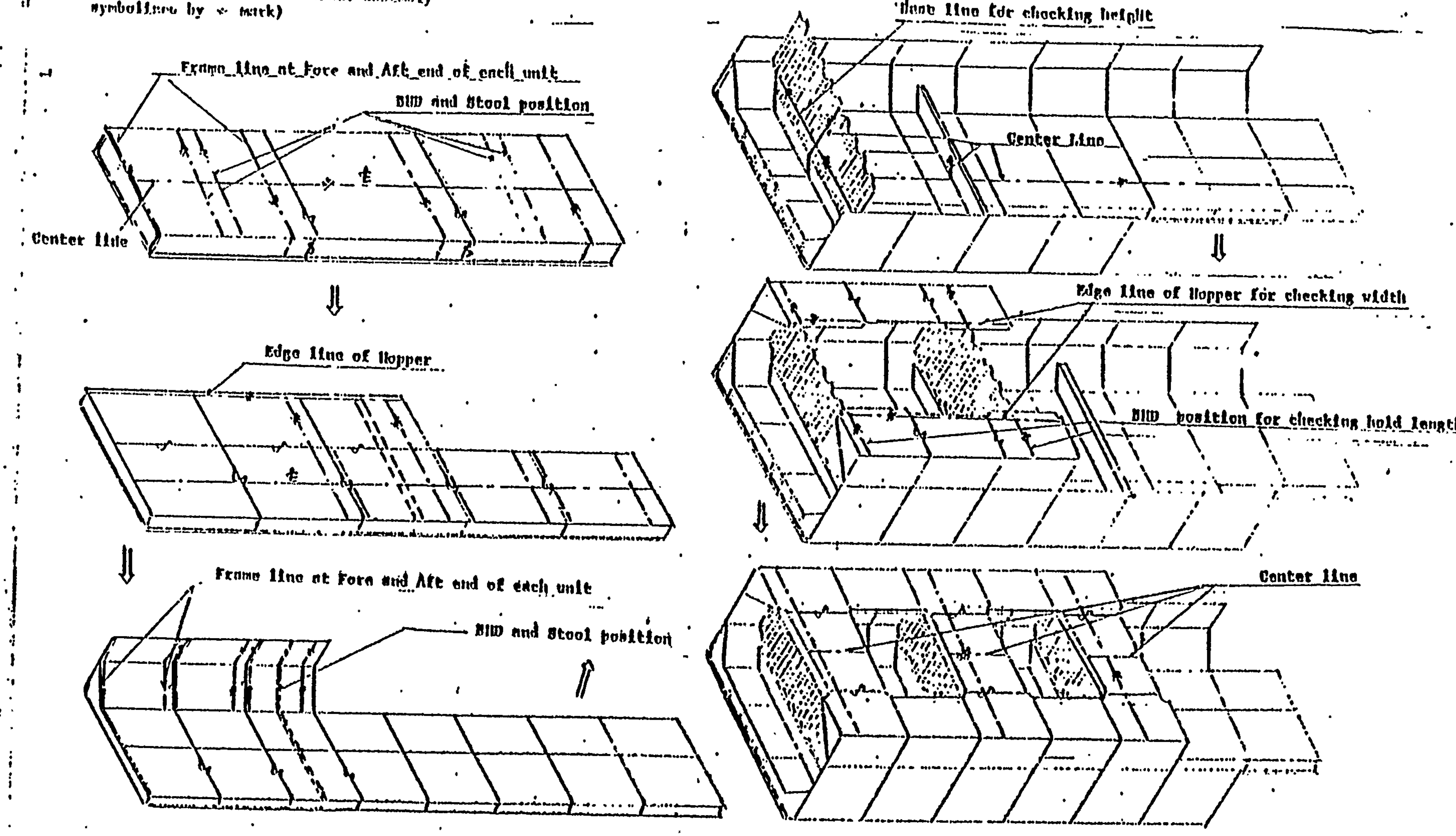
MARK	DESCRIPTION	DIMEN-SIONS	TOLER-ANCE	CHARGE	NOTICE
A					
B					
C					
D					

ACCURACY CONTROL

HOW TO DO SHIPWRIGHTING BASED ON ERECTION SEQUENCE

PREPARED BY IHI

BASE LINES FOR SHIPWRIGHT AT ERECTION
(These are all marked at final assembly
symbolized by ⊕ mark)

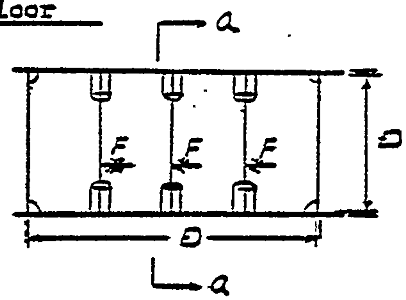
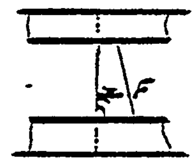
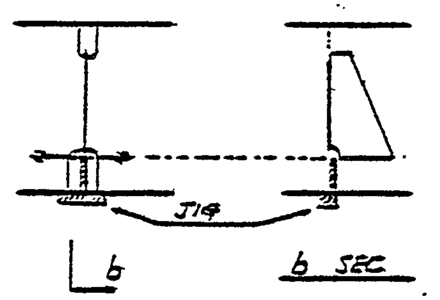
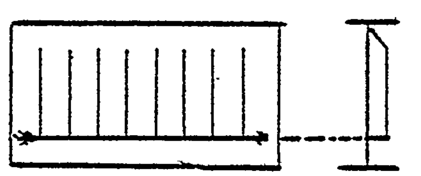
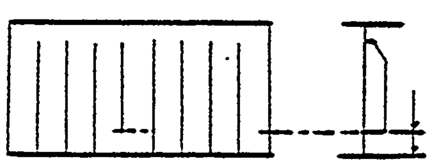


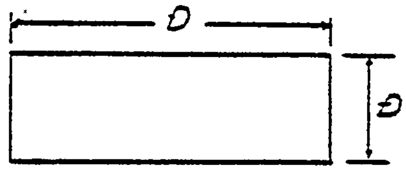
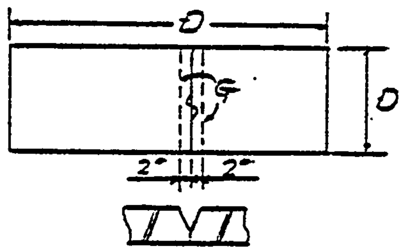
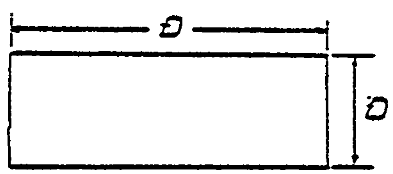
ACCURACY CONTROL

VITAL POINTS AT FABRICATION PHASE
(MARKING, GAS CUTTING, SUB-ASSEMBLY) AND
BASE LINES
TO BE INVOLVED IN THE OUTPUT FROM
MOLD LOFTING

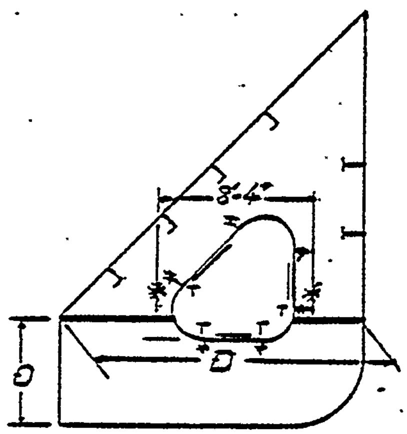
PREPARED BY IHI

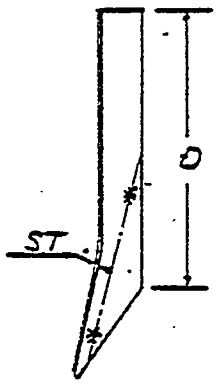
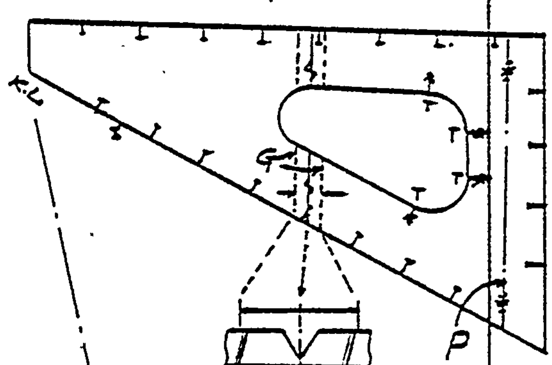
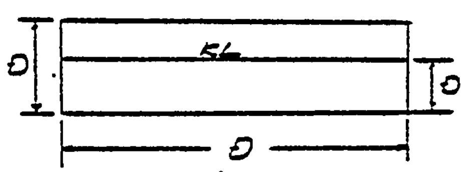
HULL 751 (Zone-1) BASE LINE & CHECK LINE FOR VITAL POINTS

MEMBER & ITEM	MEANING & PURPOSE	NOTES
Bottom Floor 	D : Dimension to be checked *The dimension is marked by NC operator and measured after cutting and sub-assembly.	Limited to the case of the neat cut before sub-assembly.
 a-a SEC  b SEC	F : Guide lines for fitting stiffeners. *To be marked by NC burning machine. *To be used for fitting stiffeners at sub-assembly *Two methods to be useful 1) to be marked at the end of stiffeners (Jig to be used) 2) to be marked at the fixed points.	
Tight Floor & Wall 	*To be marked at the end of stiffeners.	
	*The dimension should be indicated in case that only one stiffener is different from others.	

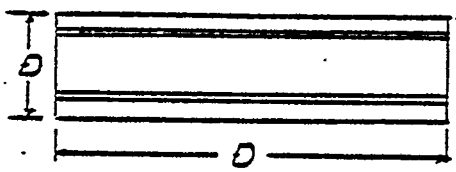
MEMBER & ITEM	MEANING & PURPOSE	NOTES
Girder 	D : Dimension to be checked	
 Joined at Sub-Assembly	G : Check lines of gas cutting	
Bottom & T. Top Plate 		

MEMBER & ITEM	MEANING & PURPOSE	NOTES
Bilge Part	D : Dimension to be checked	
	8'-4" : Check lines to be marked by NC machine for checking deformation by heating through gas cutting and welding	
	T : Tangency to be marked by NC machine for fitting of face plate	

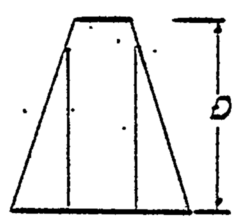


MEMBER & ITEM	MEANING & PURPOSE	NOTES
Side Shell		
	D : Dimension to be checked ST: Check line for deformation by heat. To be marked by NC machine or by hand.	
Upper Wing Tank		
	G : Check line of gas cutting. P : Check line for perpendiculary to be marked by NC machine. T : Tangency To be marked by NC machine.	
Knuckled Plate		
		

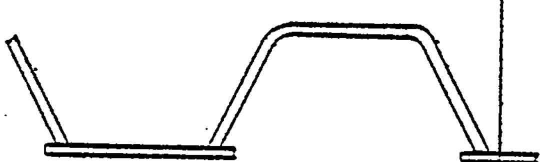
MEMBER & ITEM	MEANING & PURPOSE	NOTES
Hopper		
Top Plate	D : Dimension to be checked	



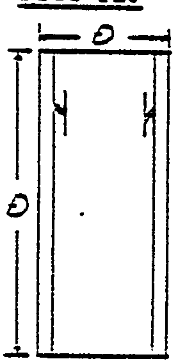
Floor



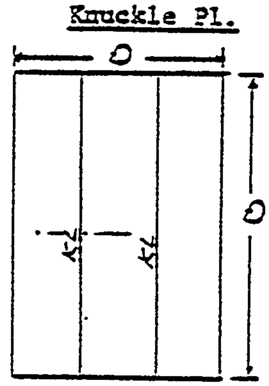
Corrugated Bhd.

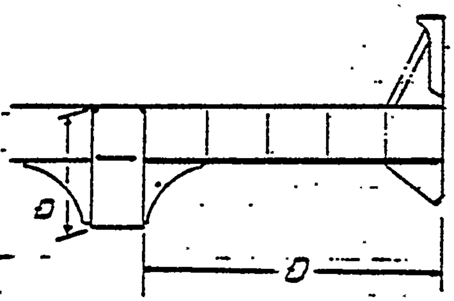
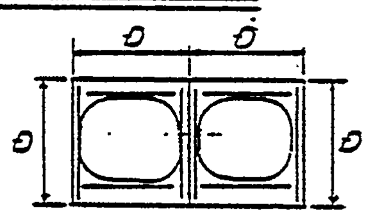
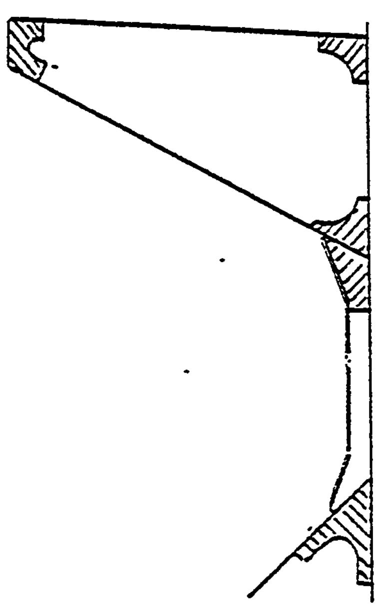


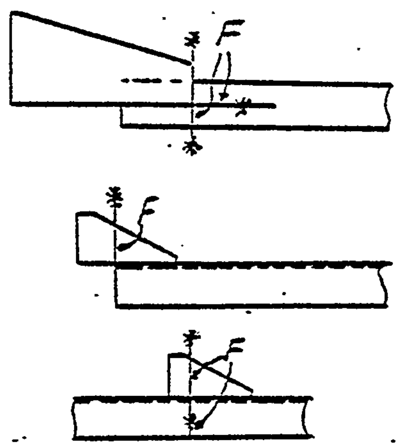
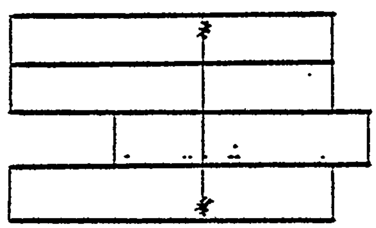
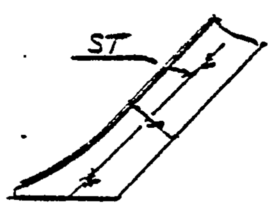
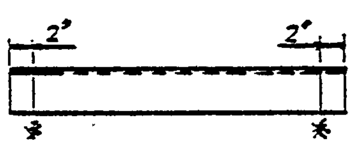
Flat Pl.



Knuckle Pl.



MEMBER & ITEM	MEANING & PURPOSE	NOTES
Center Of Upper Deck 	D : Dimension to be checked	
Duct Keel (Bottom) 		
	Bracket: Shaded brackets are vital to keep the shape of Hull.	

MEMBER & ITEM	MEANING & PURPOSE	NOTES
Sub-Assembly (Angle)		
	F : Guide line for fitting to be marked by NC machine or by hand.	
	Guide line for plate joining: In case that some ends of plate are different from others, a base line should be marked for plate arrangement.	
	ST: Check line for deformation by heat.	
	Check line for gas cutting	

IHI MARINE TECHNOLOGY, INC.

ACCURACY CONTROL

CHECK SHEET

FOR FUTURE-32 BULKERS

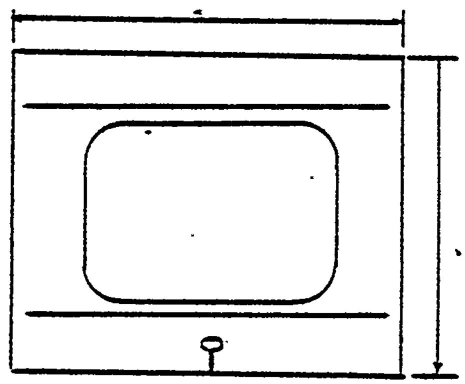
PREPARED BY IHI

REF. NO. KCT038

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	

BOTTOM CENTER UNIT FLOOR



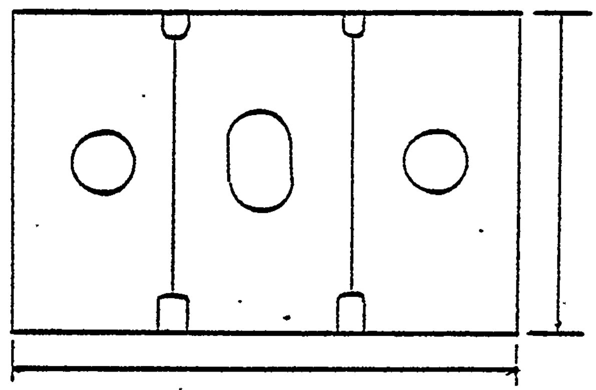
WRITER

PIECE NAME	HEIGHT	UPPER SIDE WIDTH	LOWER SIDE WIDTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	Sampling check

BOTTOM CENTER UNIT FLOOR



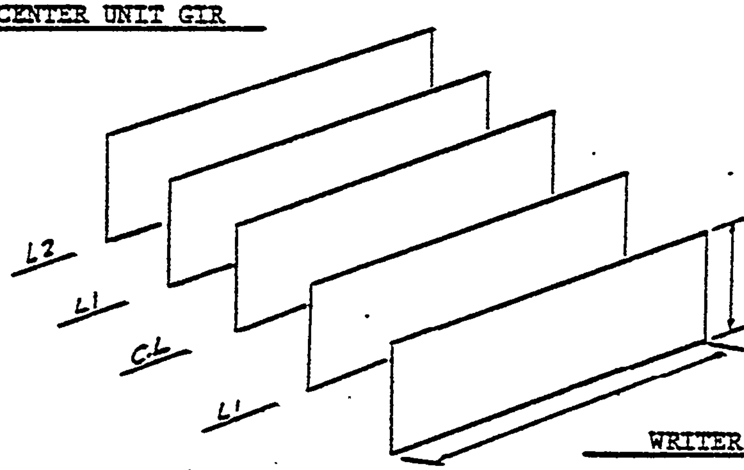
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	ALL Pieces

BOTTOM CENTER UNIT GIR



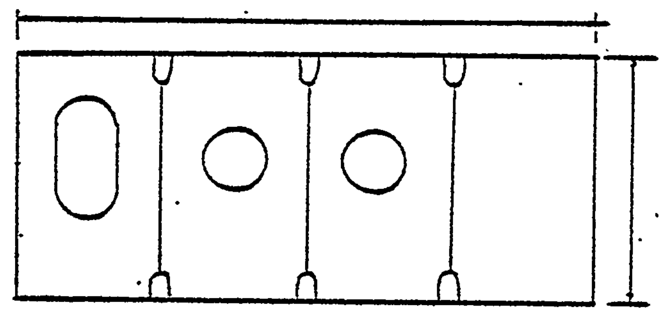
WRITER

UNIT NO.	PIECE NAME	LENGTH	HEIGHT	UNIT NO.	PIECE NAME	LENGTH	HEIGHT

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	Sampling: 2 pc/plate

BOTTOM SIDE UNIT FLOOR



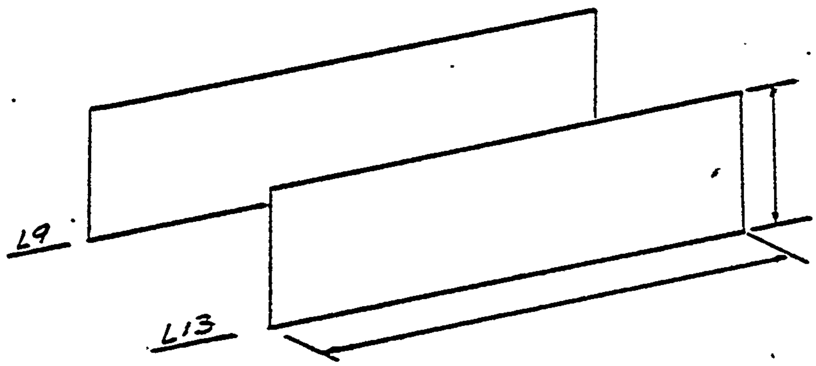
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As.	All pieces to be checked

BOTTOM SIDE UNIT GIRDER



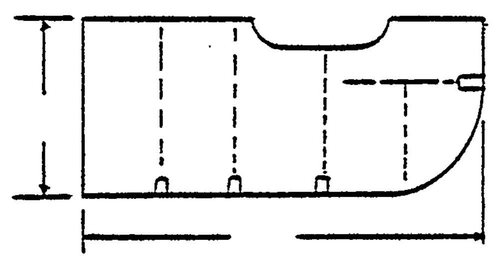
WRITER

UNIT NO.	PIECE NAME	LENGTH	UNIT NO.	PIECE NAME	LENGTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub-As.	Sampling check 2 pieces/plate

Bilge Shell Unit Floor



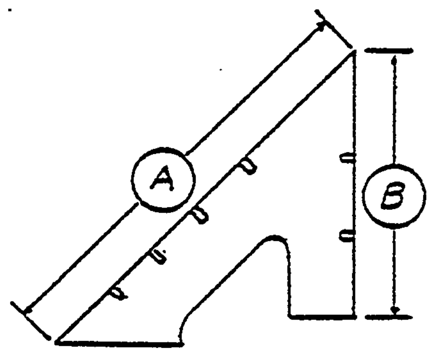
WRITER

PIECE NAME	HEIGHT	WIDTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub-As.	Sampling check: 2 pieces/plate

Hopper Side Tank Unit Floor



(INCLUDING WATER TIGHT BHD.)

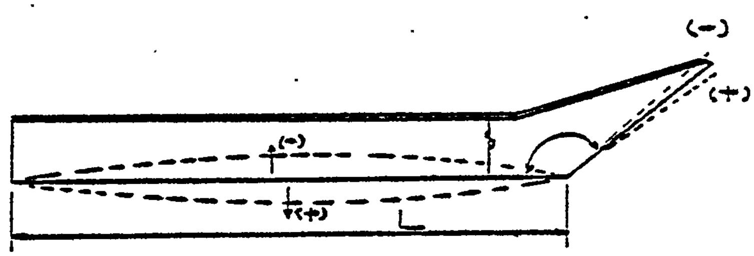
WRITER

PIECE NAME	HEIGHT A	HEIGHT B

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces to be checked

HOLD FRAME



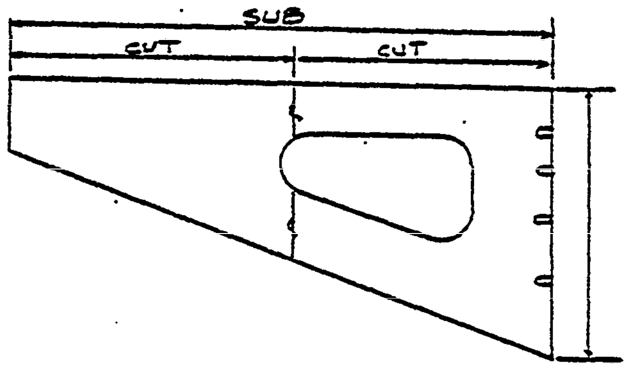
WRITER

PIECE NAME	LENGTH (L)	DEFORMATION	ANGLE

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub.As	Cutting: Sampling check Sub: All piece check

TOP SIDE TANK UNIT FLOOR



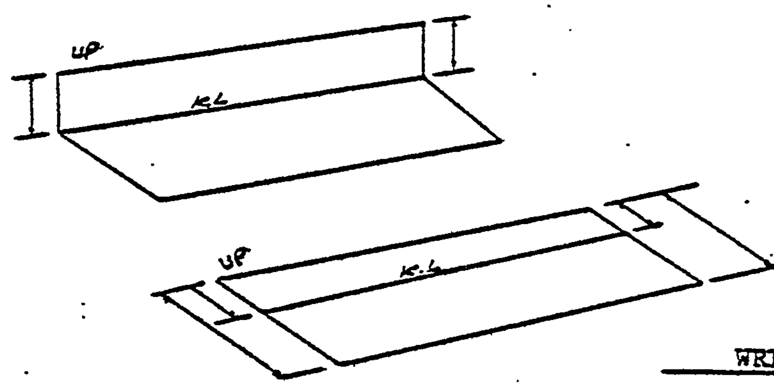
WRITER

PIECE NAME	WIDTH	HEIGHT

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut.-Bending	All Pieces Check

TOP SIDE TANK UNIT THE KNUCKLED PLATE



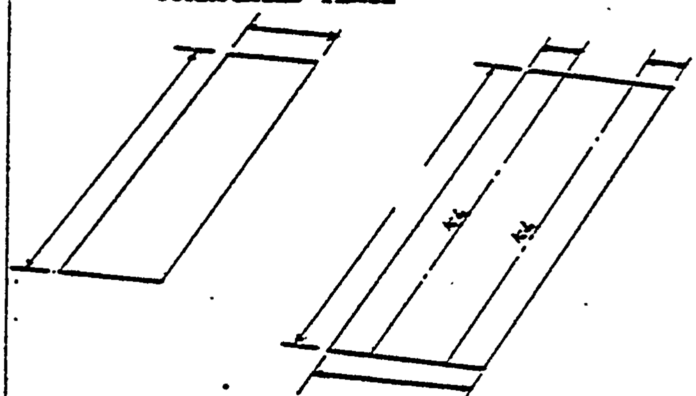
WRITER

UNIT AND PIECE NAME	AT FORE END		AT AFT END	
	WIDTH	Distance from kl. to edge	WIDTH	Distance from kl to edge

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cutting	Sampling: 2 pieces/unit

CORRUGATED DEEP TANK BHD. FLAT PLATE & CORRUGATED PLATE



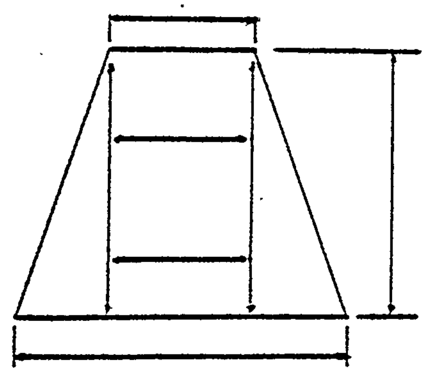
WRITER

PIECE NAME	WIDTH			LENGTH

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Cut. Sub As.	Sampling Check

STOOL UNIT FLOOR.



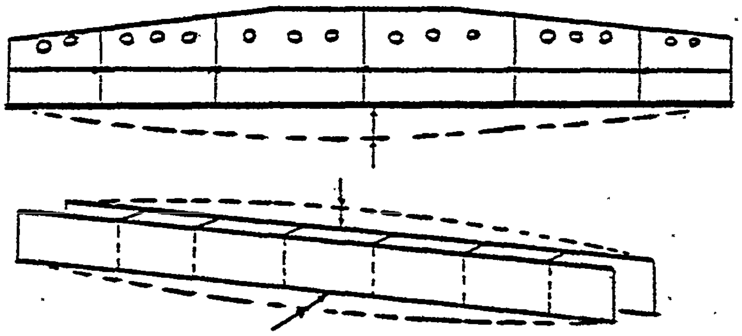
WRITER

PIECE NAME	HEIGHT	WIDTH AT UPPER PART	WIDTH AT LOWER PART

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
		Sub-Assembly	All pieces checked

UPPER DECK CENTER UNIT HATCH END BEAM AND BOX BEAM



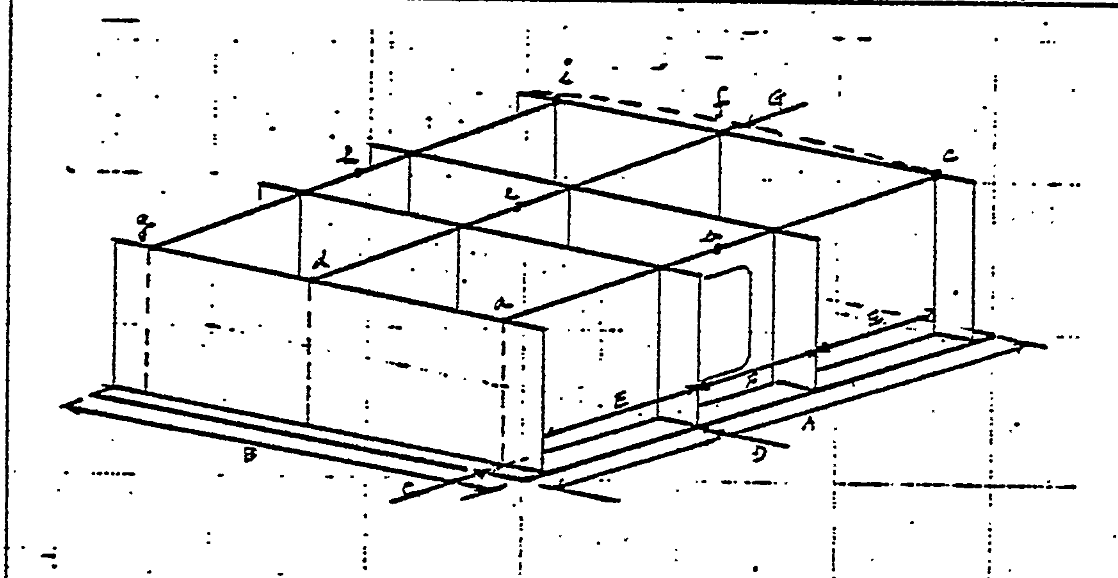
WRITER

PIECE NAME	DEFORMATION OR DISTORTION

IHI MARINE TECHNOLOGY, INC.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bottom plate

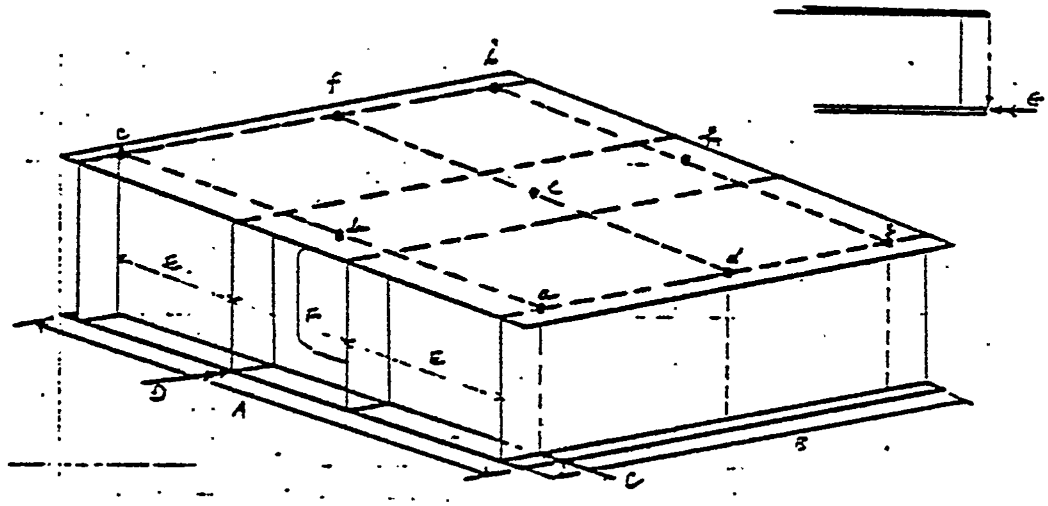


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C				P S	Worker AC	Both side (P.S)
D	Edge Alignment			F A	"	Every Girder Both Side (F.A.)
E	Girder Spacing			P S	"	Every Frame
F	"			FORE AFT	"	Both side (F.A.)
G	Straightness				"	Each girder show maximum.
H	Level			a b c d e f g h i j	"	9 points a - i

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

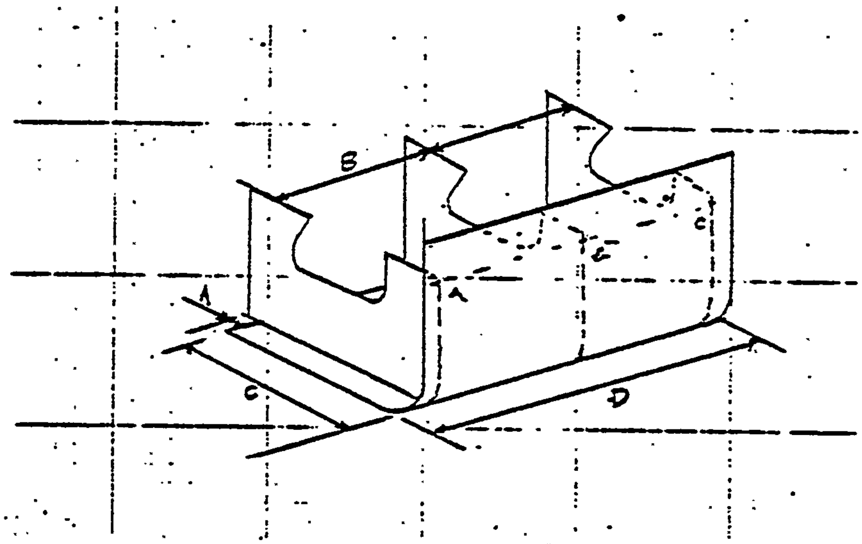


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
C				P / S	Worker AC	Both side (PSI) Each Frame
D	Edge Alignment			F / A	"	Every Girder Both side (F.A)
E	Girder Spacing			P / S	"	Every Frame
F	"				"	Both Side (F.A.)
G	Relativity				"	2 points each edge
H	Level			a b c d e / f g h i j		9 Points (a-i)

Notice After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with side shell

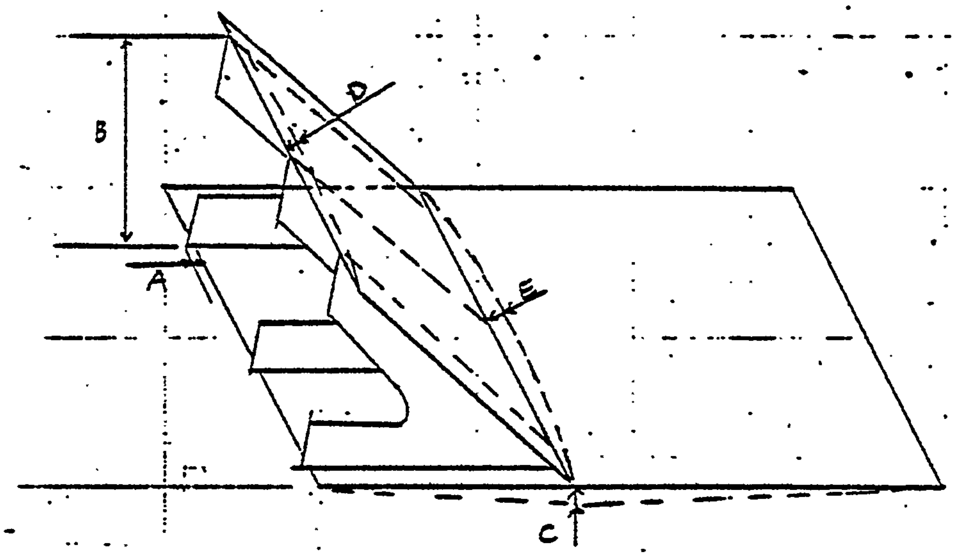


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Trans Web.
B	Transv. Spacing							"	"
E	Deformation			a	b	c		"	3 points (a,b,c)
C	Width							AC	
D	Length							AC	

Notice: After welding, fitting

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before combined with bilge unit

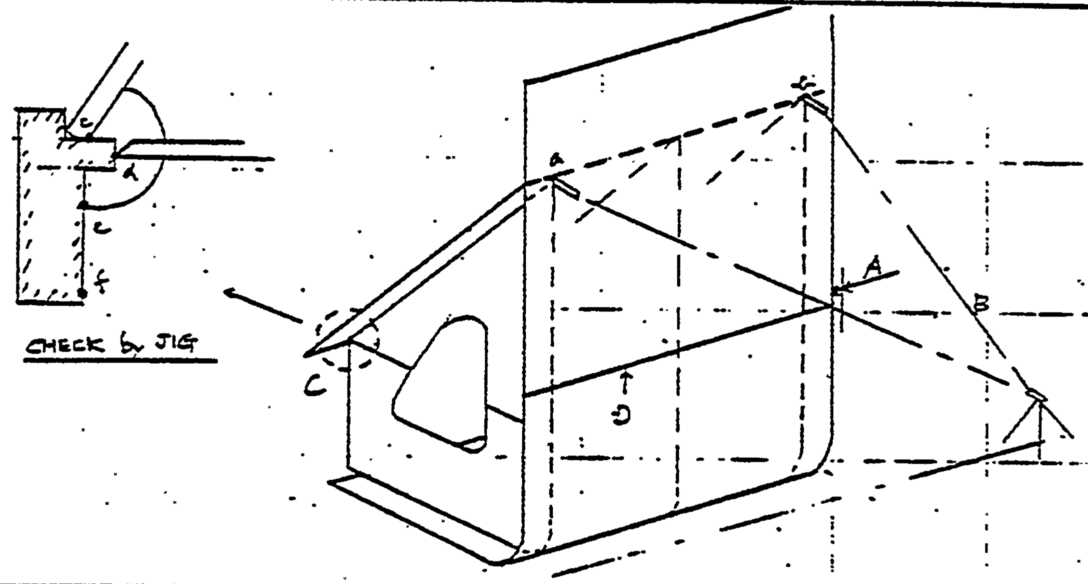


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Edge Alignment							Worker AC	Every Transv. web
B	Width at Slant Plate							AC	"
C	Knuckle at Side Shell							AC	"
D	Bending at Slant Plate							"	"
E	Bending at Side Shell							"	"

Notice After fitting welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Unit to Unit

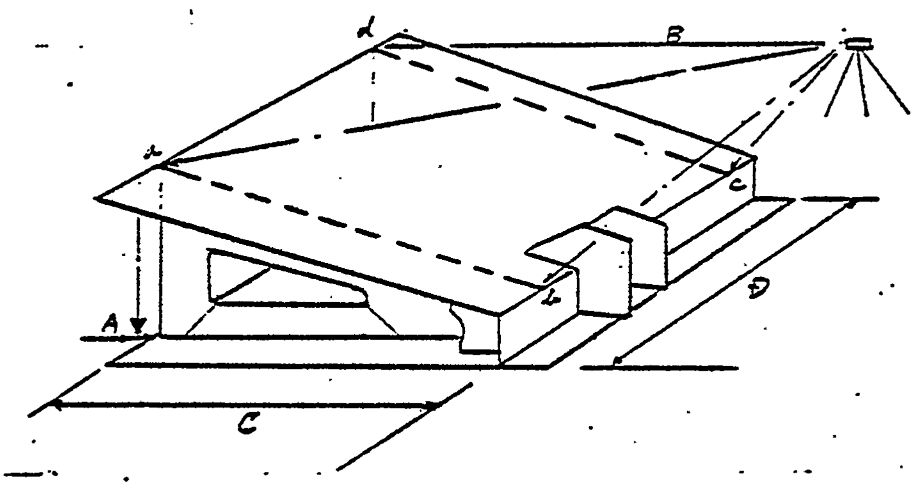


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Butt Alignment			FORE / AFT	Worker	Both side (A.F.)
B	Inclination			FORE / AFT	Worker AC	(a,b)
C	Alignment			c / d / e / f	"	Check by special jig.

Notice
1. After fitting and welding
2. Top seam at bilge should be checked and finished up before setting side shell unit.

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Before final unit assembly under the base of the Upper Deck.

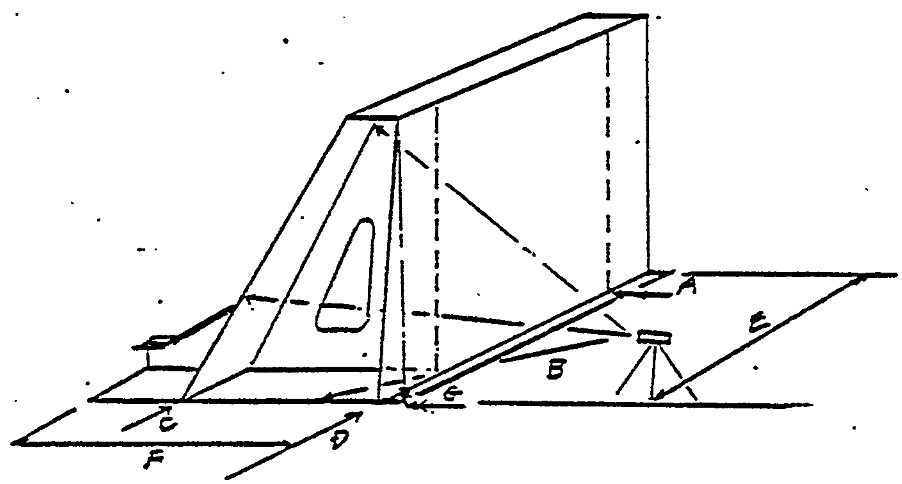


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Shift between U.Dk. & Top Side				Worker AC	Every Frame
B	Level				"	4 points (a-d)
C	Width				"	
D	Length				"	

Notice: After fitting, welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

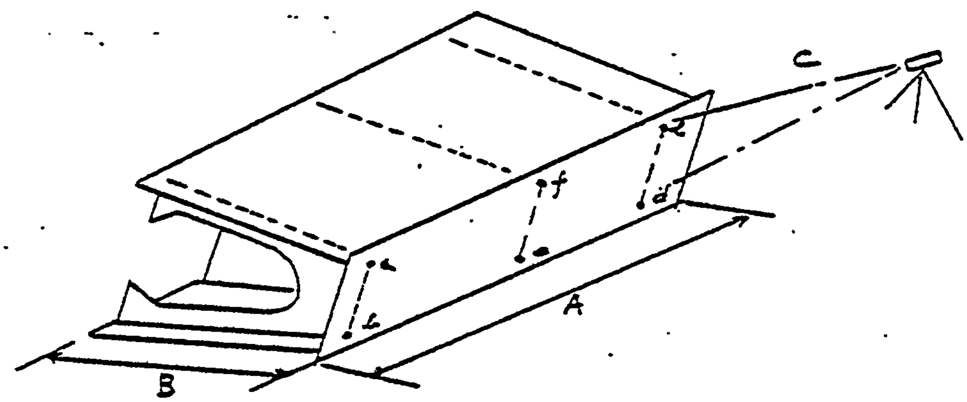


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension				Chg.	Notice
A	Shift							Worker AC	Every Frame
B	Edge Alignment			AFT		FORE		"	Both end (aft. fore)
C	Straightness							"	
D	Straightness							"	
E	Length							"	
F	Height							"	
G	Inclination			AFT		FORE		"	Both End

Notice : After fitting, welding

ACCURACY CHECK SHEET

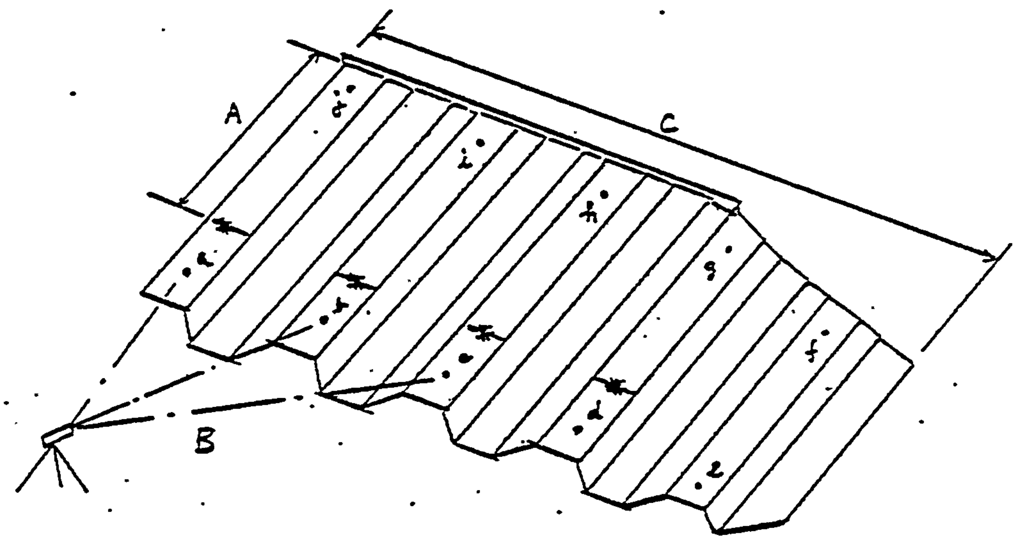
Ship No.	Unit No.	Shop	Condition
			Final Unit



Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Width				AC	
B	Height				"	
C	Flatness				"	2 points at each frame

Notice: After fitting,welding

ACCURACY CHECK SHEET			
Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly

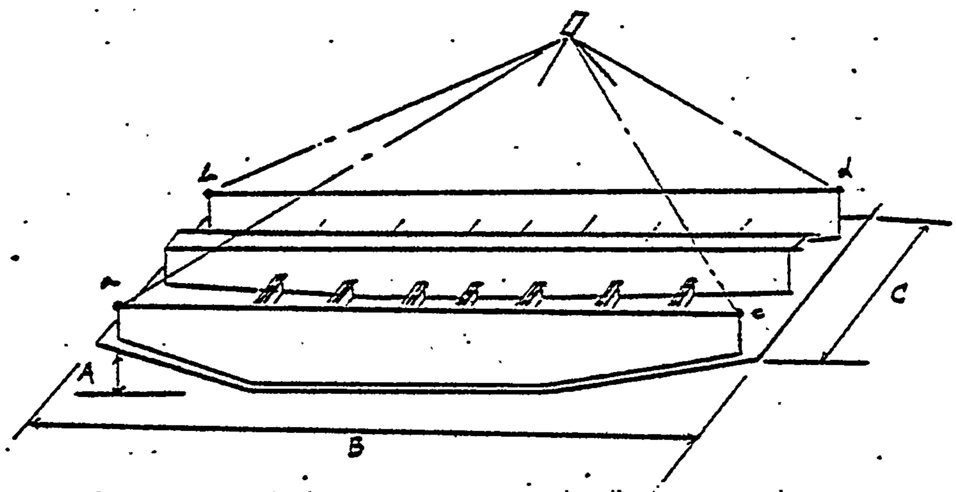


Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Height				Worker	Mark check line for shipwright
B	Level				"	After checking level fix by temp. beam
C	Width					

Notice : After fitting,welding

ACCURACY CHECK SHEET

Ship No.	Unit No.	Shop	Condition
			Final Unit Assembly



Mark	Item	Dim's in Drawings	Allow. Tol.	Actual Dimension	Chg.	Notice
A	Camber Height				Worker AC	4 corners
B	Width				AC	
C	Length				"	
D	Level				Worker AC	4 points

Notice: After fitting, welding

ACCURACY CONTROL

THE SCHEME OF THE ADDED MATERIALS

AND

THE PHASE FOR FINISHING UP

FOR

THE FUTURE-32 BULKERS

AT

IHI AIOI-SHIPYARD

PREPARED BY IHI

REF. NO. KCT039

ACCURACY CONTROL

The scheme of the added Material and the Phase for Finishing Up for the FUTURE-32 Bulkers at IHI AIOI-Shipyard.

This paper is to display how the activities of accuracy control at IHI AIOI-Shipyard are being performed in the field of planning for the added material and finishing up phase.

The scheme of the subject is usually planned by the A/C Group (Accuracy Control Group which is the nucleus for promoting the A/C activities and is constituted by eight (8) engineers of the Hull Construction Department). This is planned for main structures the ship's hull using preliminary design drawings such as Midship Section, Shell Expansion, Upper Deck Plan, Inner Bottom Plan and the other construction profiles.

It seems to be very significant to notice that the Dlanning of the subject precedes the begining of making working drawings, that is, this scheme is a guidance for making working drawings to indicate the actual fabricating method of the ship’s hull.

This scheme is designed taking into account of the following fundamental fuactions to build the actual ship:

(1) Vital points and vital dimensions to keep high accuracy.

(2) Fabricating sequence and fabricating method for a unit.

(3) Erection sequence of units

(4) Welding method

(5) Consideration for shrinkage

The main target of the activities of accuracy control at IHI lies in minimizing the work at erection because erection work on board is unsuitable comparing with the work at assembly or work in shop any view point such as safety, quality and efficiency.

This idea shall be easily found in the following drawings. Some remarkable characsestistics in it are as follows:

(1) Finishing up (cutting) at erection is quite a few Only a few joints (seams and butts) at Bow and Stern are designed to be finished up at erection.

(2) Dimensions of added material and phase where those are finished up are clearly indicated.

-Neat cut Without any added material at cutting stage.

-Finish cut with some added material for the margi shrinkage at cutting stage (marked in 3).

-Finish cut without any added material at assemb (market in A).

-Finish cut with some added material for the margi shrinkage at assembly (marked in A4).

-Finish cut at final assembly after checking unit dimensions (marked in 30).

-Finish cut on board after checking dimension before erection of the succeeding unit (marked in E).

-Finish cut on board adjusting joint as the time of erection of the succeeding unit. (marked in).

(3) Welding Method

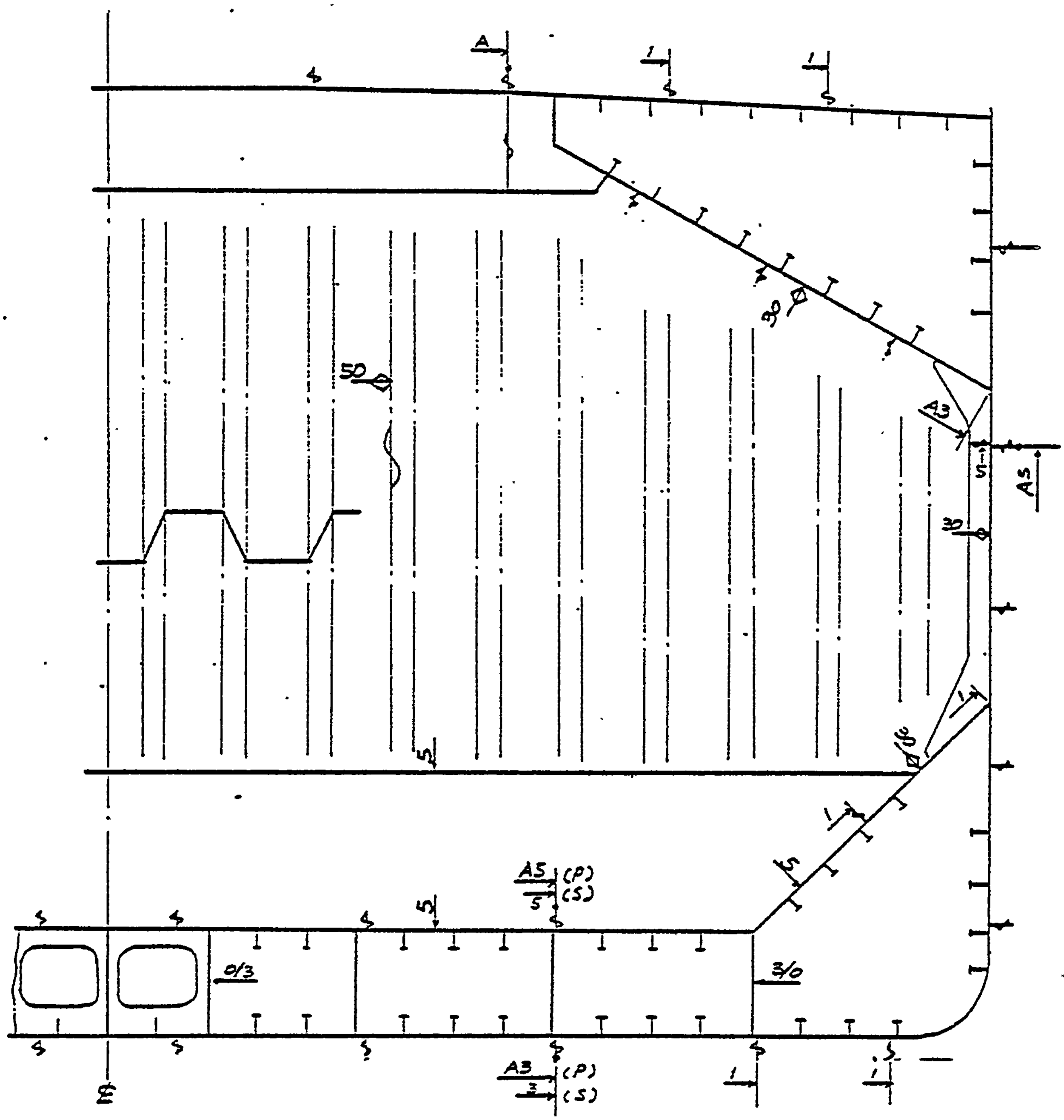
Automatic welding method adopted to the seems and butts are shin.

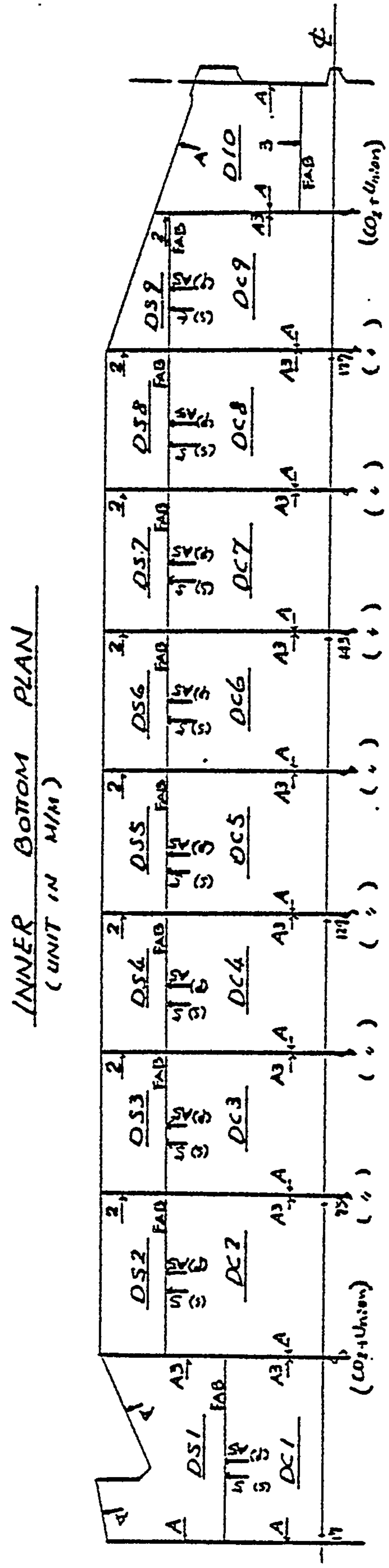
-E.G.
Electro Gas Welding

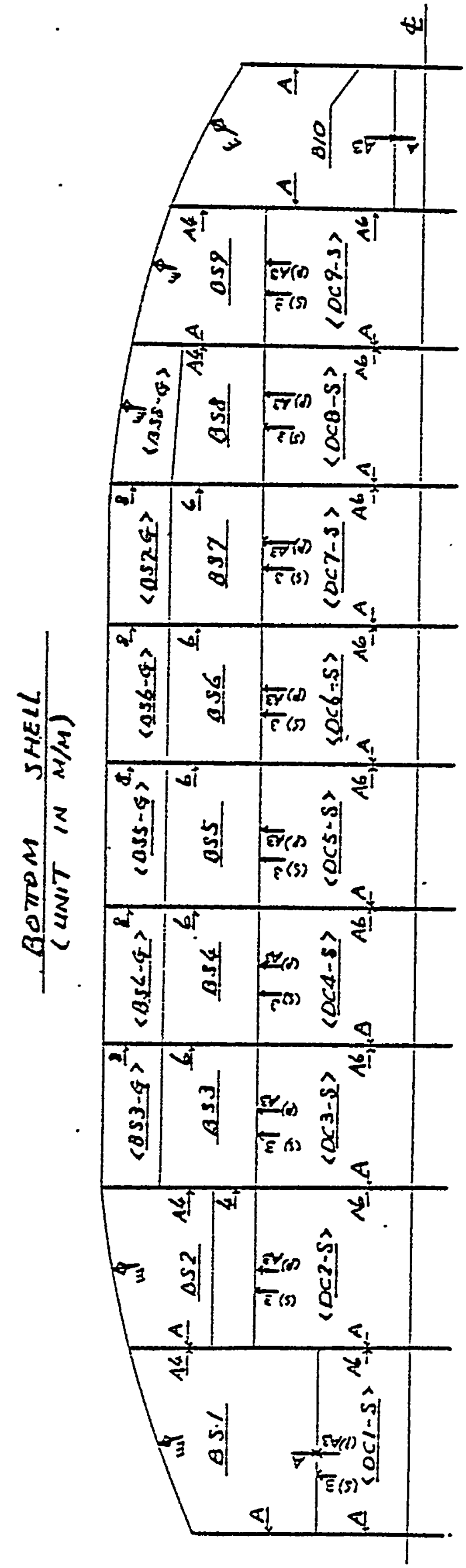
--CO_2
CO_2 Semi-Automatic Welding

-FAB
Flux Asbestos Backing Welding

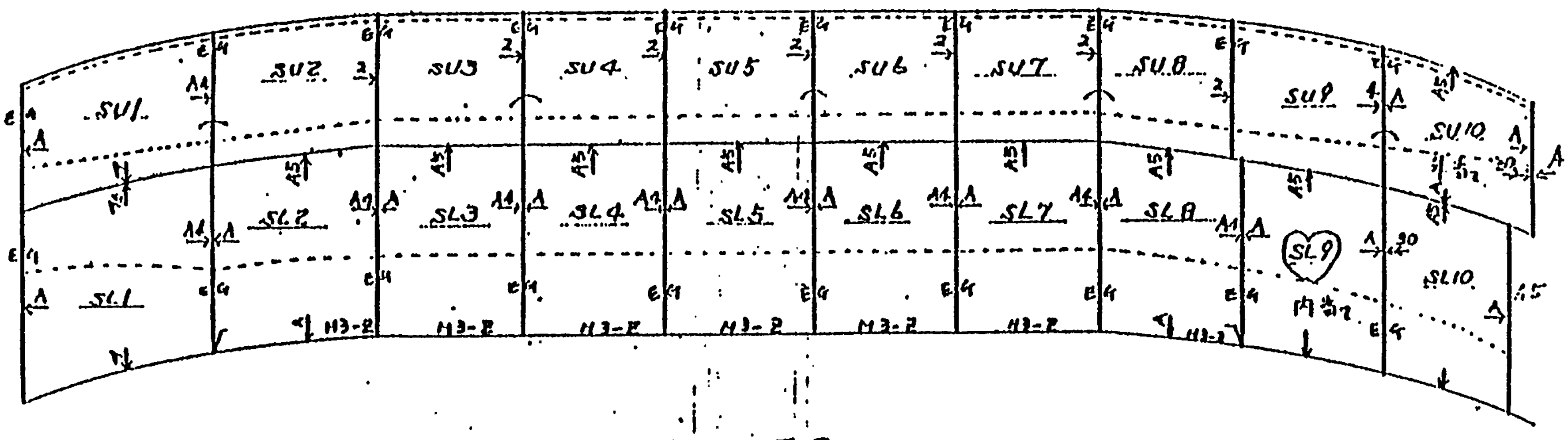
MIDSHIP SECTION
(UNIT IN M/M)



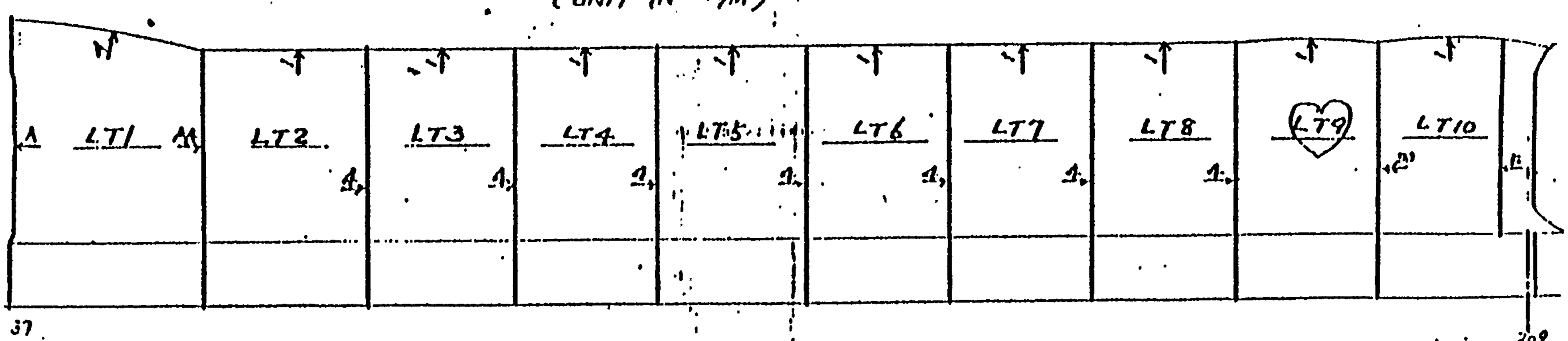

INNER BOTTOM PLAN
(UNIT IN M/M)


BOTTOM SHELL
(UNIT IN M/M)

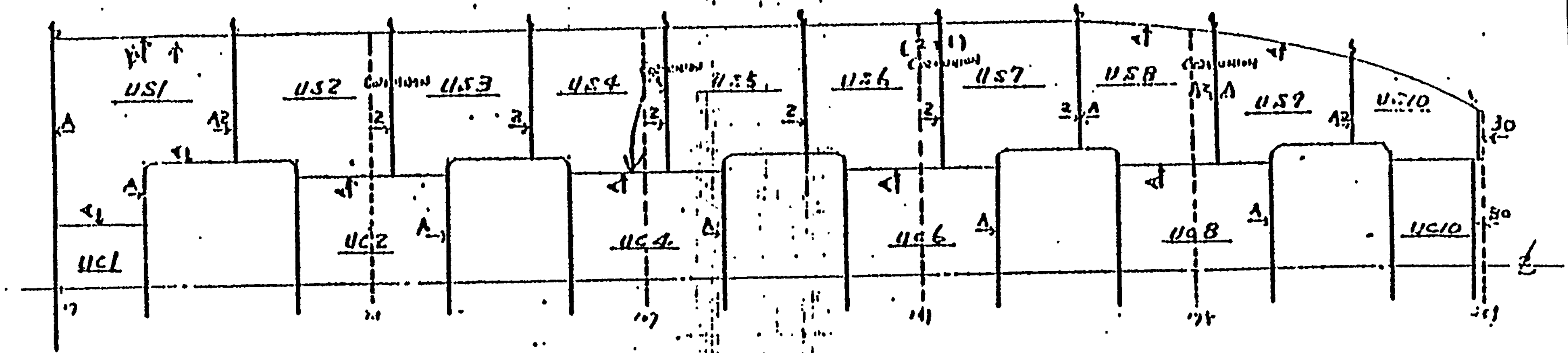
SHELL EXPANSION
(UNIT IN M/M)



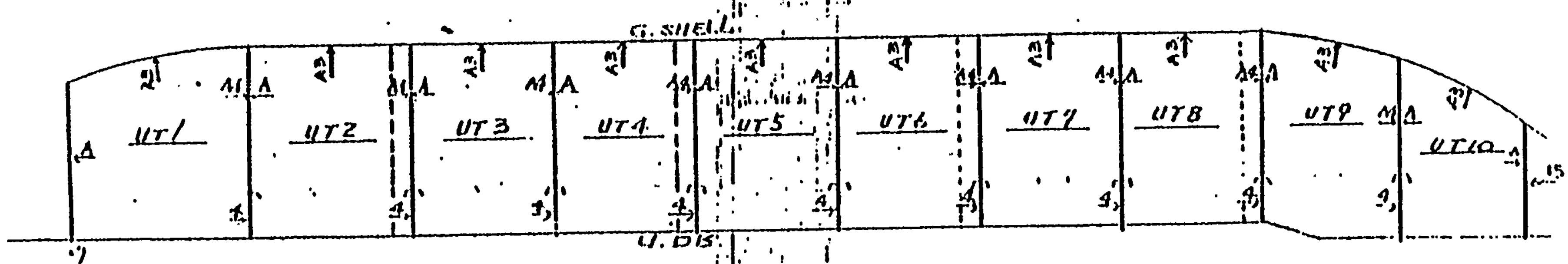
HOPPER TANK TOP
(UNIT IN M/M)

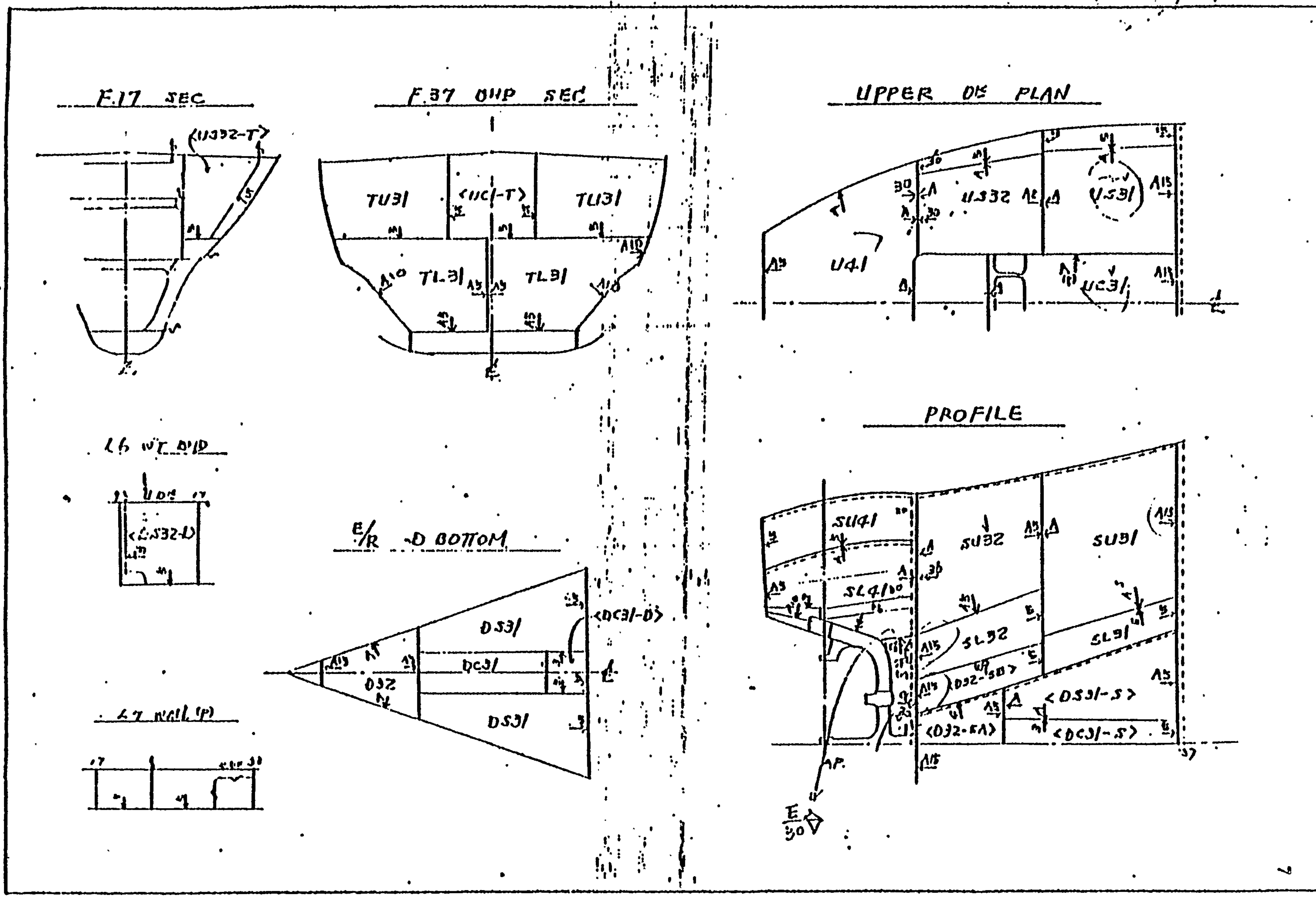


UPPER DECK
(UNIT IN M/M)

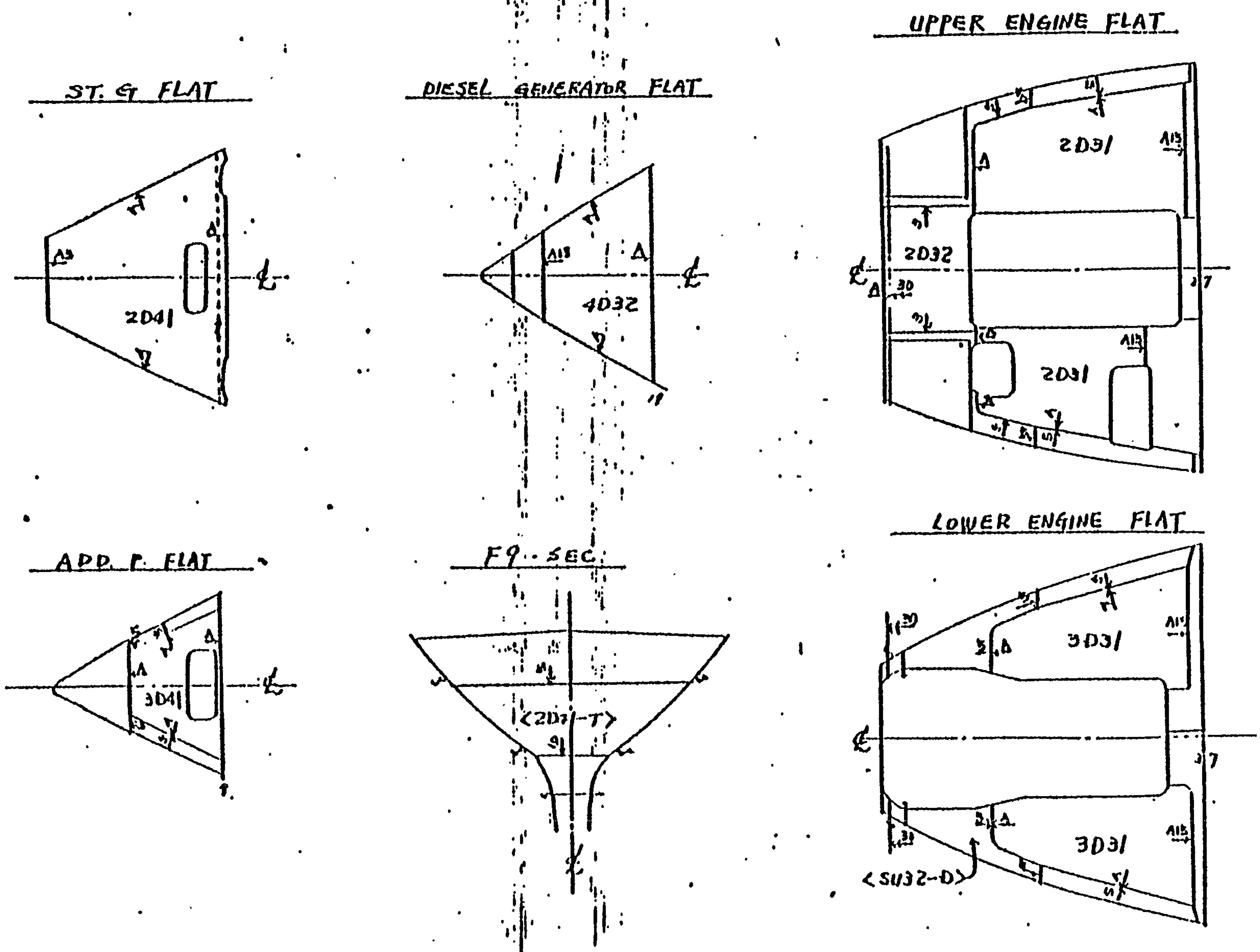


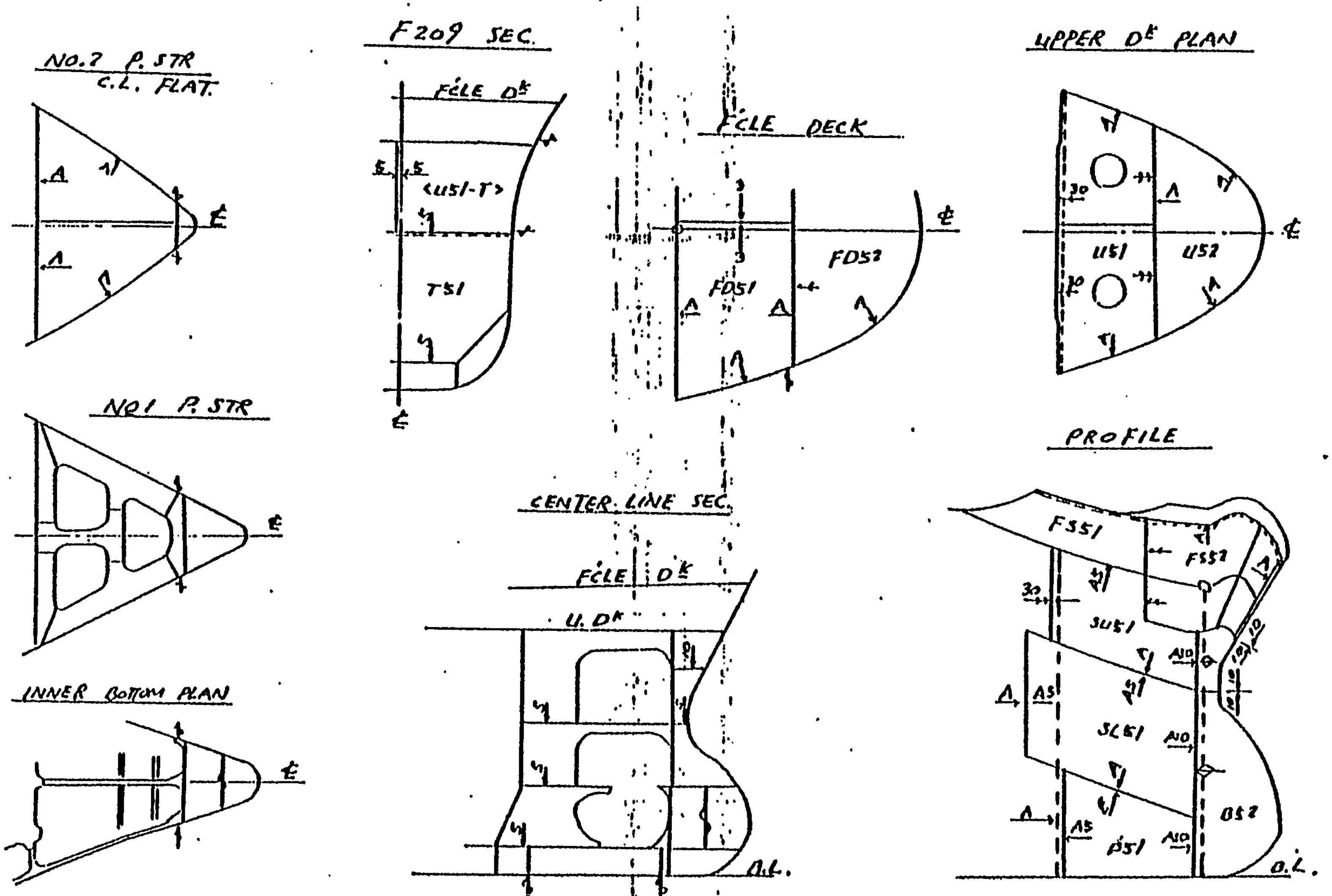
TOP SIDE TANK BOTTOM
(UNIT IN M/M)



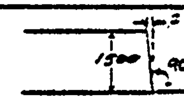
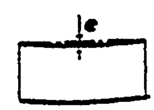
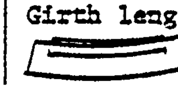
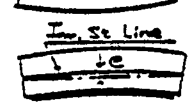
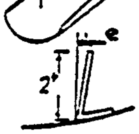


F.17 SEC
(U332-T)
F.37 DHP SEC
TU31
(UC1-T)
TL31
UPPER DK PLAN
U41
U332
U531
UC31
L6 WT BHD
(LS32-D)
E/R D BOTTOM
DS31
DC31
DS2
(DC31-D)
L7 WALL (P)
PROFILE
SU41
SU32
SU31
SL41
SL32
SL31
(DS2-SB)
(DS31-S)
(DS2-SA)
(DC31-S)
AP.


ST. G FLAT
2D41
DIESEL GENERATOR FLAT
4D32
UPPER ENGINE FLAT
2D31
2D32
2D31
APP. P. FLAT
3D41
F9 . SEC.
<2D7-T>
LOWER ENGINE FLAT
3D31
3D31
<SU32-D>


NO.2 P. STR
C.L. FLAT.
NO.1 P. STR
INNER BOTTOM PLAN
F209 SEC.
FCLE Dk
<US1-T>
TS1
FCLE DECK
FDS1
FDS2
CENTER LINE SEC.
FCLE Dk
U. Dk
B.L.
UPPER Dk PLAN
US1
US2
PROFILE
FSS1
FSS2
SUS1
SLS1
BS1
BS2
B.L.

STANDARD AND TOLERANCE FOR A.C. AT THE AIOI SHIPYARD

SHOP	ITEMS	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
Marking & Gas Cutting				
(Section)				
(Fb)	*Check line for gas cutting of angles (after marking)	e = ± 1.5/64"	8 pc/day (piece/day)	
	*Check line for gas cutting of angles (after cutting)	e = ± 1/32"	5 pc/day	
	*Length of angles (after cutting)	e = ± 1.5/64"	5 pc/day	
(Internal Member)	*Normality after gas cutting (Right Angle)	2/1500	5 pc/day	
	*Check line for gas cutting	e = ± 1/32"	Do	
	*Length after gas cutting	e = ± 3/64"	Do	
	*Width after gas cutting	e = ± 3/64"	Do	
Flame planer	*Length & Width after cutting	e = ± 1.5/64"	5 pc/day	
(Flat shell plate flat plate)	*Straightness	e = ± 1/64"	2 pc/week	
	*Bevel Angle	e = ± 2.0 deg.	5 pc/day	
	*Normality (Right Angle)	e = ± 2/1500	2 pc/week	
Bending (Section)	*Length of frames after bending	e = ± 1.5/32"	5 pc/day	Girth length 
	*Straightness of inverted straight line of frames after bending	e = ± 3/32"	5 pc/day	
(Plate)	*Round gunwale plate & Bilge plate	e = ± 1/8"	All	
	*Setting degree of template	e = ± 1/4"/2"	All	
	*Discrepancy between template and end of plate	e = ± 1/4"		

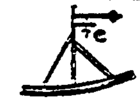
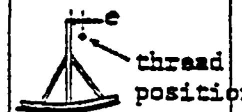
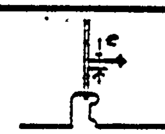
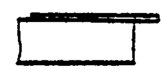
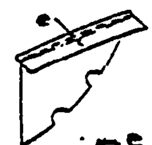
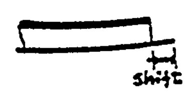
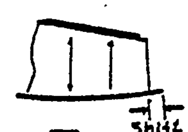
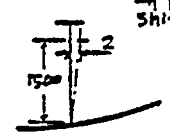
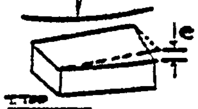
STANDARD AND TOLERANCE
FOR KEEPING HIGH ACCURACY
AT IHI AIOI SHIPYARD

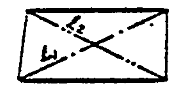
*Standard at each shop

*Standard for maintenance and check
of facilities and instruments

Prepared by
IHI

REF. NO. KCT040

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
Bending	*Height of sight seeing line	e = ± 1.5/16"	5 pc/day	
	*Discrepancy of sight seeing line between templates and thread	e = ± 1/4"	5 pc/day	
Sub-Assembly	*Positioning of stiffeners (FB. BKT) on a web plate	e = ± 1/32"	8 pc/day	
	*Positioning of face plate to a web plate (keep shift dimension)	e = ± 1/32"	8 pc/day	
	*Flatness of sub after sub-assembly	e = ± 1/8" (LS 31' 14") -e = ± 1/4" (L 31' 14")	8 pc/day	
	*Fitting angle of stiffeners to a web plate	e = ± 3 deg.		
	*Deformation of sub-unit	e = ± 1/4"	8 pc/day	
Assembly Fitting	*Shift dimension between skin plates and frames/girders	e = ± 1.5/32"	5 pc/day	
	*Shift dimension between skin plates and trans. web/floors	e = ± 1.5/32"	5 pc/day	
	*Fitting angle between trans. web and skin plates	e = ± 5/1500	5 pc/day	
	*Fitting angle between frames and skin plates	e = ± 1/8" (at the top)	5 pc/day	
	*Level	e = ± 1/4"	All	
	*Perpendicularity check by a plummet	e = ± 1/16" (at the end point)	All	
	*Flatness of a unit	e = ± 1/4"/L	20%	

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
<u>Assembly</u>				
<u>Marking</u>	*Length of plates	$e = \pm 1/8''$ (curved)	All	
	*Width of plates	$e = \pm 1.5/16''$ (plane)	All	
	*Diagonal lenght of plates (squareness check)	$\Delta L = \pm 1/4''$ (curved) $\Delta L = \pm 1/8''$ (plane)	All	 $\Delta L = \ell_1 - \ell_2$
	*Marking lines by hand	$e = \pm 1/8''$ (curved)	4 units/ 2 days	
	*Straightness of plate edge	$e = 1/16''/L$	20%	
	*Width of corrugate	$e = 1.5/16''$	All	
	Height of corrugate	$e = 1/16''$	All	
	Normality of corrugate	$e = 1.5/16''$	All	
<u>Assembly</u>				
	*Check line for gas cutting	$e = \pm 1/32''$	5 pc/day	
Gas Cutting				
	*Depth of bevel	$e = \pm 1/32''$	5 pc/day	
	*Bevel Angle	$e = \pm 2.0$ deg.	5 pc/day	
	*Straightness of plate edge	$e = \pm 1.5/32''$	20%	

STANDARD AND TOLERANCE FOR A.C. AT IHI AIOI SHIPYARD

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
<u>ERECTION</u> Bottom Shell	*Positioning: (Length wise) Measure on the check points on berth	e= ± 1/8"	starting unit only	
	*Positioning: (Height) Measure at the most forward frame (2 points)	e = ± 1/4"	All Uuints	By gauge
	*Level: (Between left side and right side) Measure on the points at forward edge	e = ± 1/4"	All units	Pay attention to twist
	*Positioning: (Betwe-en left side and right side) Measure at the forward butt	e = ± 1/8"	All units	Plum down to the base line on berth
	*Connecting part be-tween units: Check the bevels at seams and butts	e = ± 1/8"	All units	
	*Discrepancy of ship's center	e = ± 1/8"	All units	Measuring by transit

STANDARD AND TOLERANCE FOR A.C. AT IHI AIOI SHIPYARD

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Side Shell	*Positioning: (Lengthwise) Arrangement of butt between bottom shell and side shell	e = ± 1/8"	All units	Check fram space
	*Level: (Lengthwise) Check at the upper block end seam	e = ± 1/8"	All units	Check the be
	*Perpendicularly: Measure at the forward butt	e = ± 1/4"	All units	Plum down f the top or asuring by ansit
	*Positioning: (Height) Check the gap between units at side shell	e = ± 1/8"	All units	Check the h ight of T.B
	*Connecting parts between units: Check the seams and butts (bevels)	e = ± 1/8"	All units	

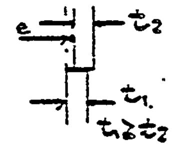
SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION	*Positioning: (Length wise)	e = ± 1/8"	All units	Measure on the rudder center of upper gudgeon
Grandly Assembled	Measure at afterend frame			
(Stern Part)	*Positioning: (Between left and right)	e = ± 1/8"	All units	Arrange with center girder at stern frame
	Fix on the center line of stern frame			
	*Positioning: (Height) Check the distance be tween flats	e = ± 1/4"	All units	Measure the dimension from upper gudgeon to the flat top
	*Connecting parts be-tween units: Check the bevels of seams and butts. Check the con-necting parts to shell	e = ± 1/4"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Supper structure	*Position of butts and walls (Lengthwise)	e = ± 1/4"	All units	Check fra space
	*Positioning: (Width wise) Relative position to the ship's center line	e = ± 1/4"	All units	Check bevel deck's seam
	*Positioning: (Height) Measure the dimension between decks	e = ± 1/8"	All units	Pay attenti to finish c at wall joi
	*Level: (Lengthwise and Widthwise)	e = ± 1/4"		Check the r ghness of t deck plate
	*Connecting parts between units: Check the feet of walls and bevels at butts and seams of walls	e = ± 1/8"	All units	Check the t and unalign at walls

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Curved Shell Unit	*Positioning: (Length wise) Alignment between a butt at bottom shell unit and a butt at side shell unit	e = ± 1/8"	All units	Check fra space
	*Level: (Lengthwise) Check at the upper block end seam	e = ± 1/8"	All units	Check the vel
	*Positioning: (Width) Check the dimension from the ship's center line	e = ± 1/4"	All Units	Plum down the base.l (center li etc.) mark on the ber (or by tra
	*Positioning: (Height) Check the gap of upper end seams between units	e = ± 1/8"	All units	Check the lationship the height T.BHD
	*Connecting parts between units.	e = ± 1/8"	All units	
	*Discrepancy of ship's center	e = ± 1/8"	All units	Measuring transit

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Super structure (Grandly assembl-ed)	*Positioning: (Length wise) Check the posi-tion of front wall	e = ± 1/4"	All units	Check the easy continuity at front wall
	*Positioning: (Width wise) Relative posi-tion to the ship's center line	e = ± 1/8"	All units	Check the easy continuity at side walls
	*Positioning: (Height) Measure the dimension between decks	e = ± 1/8"	All units	Pay attention to finish cut at walls
	*Connecting parts be-tween units: Check un-alignment at the feet of walls	e = ± 1/4"	All units	Pay attention to alignment width

STANDARD AND TOLERANCE FOR A.C. AT IHI AIOI SHIPYARD

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION T. BHD	*Positioning: Align-ment of plates of T. BHD	e = 1/3 * t2	All units	
	*Level: Check at the both end point of upper end seam	e = ± 1/4"	All units	Check the be-vel
	*Perpendiculary: Check at the outside stiffener	e = ± 1/4"		Plum down from the top (or by transit)
	*Positioning: (Width) Check the dimension from the center line marked the bottom sh-ell	e = ± 1/8"	All units	
	*Connecting parts be-tween units: Check the bevels at seams and butts	e = ± 1/8"	All units	
	*Positioning: (Height) Check the relationship of upper end seams be tween units	e = ± 1/4"	All units	Check the al-ignment at the H.GIR

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION L. BHD	*Positioning:(Length wise) Shift dimension at the butt between the L. BHD and the bottom shell unit	e = ± 1/4"	All units	Check the ame space
	*Level: (Lengthwise) Check at the upper and seam	e = ± 1/8"	All units	Check the vel
	*Perpendiculary: Check at the for-end frame of the unit	e = ± 1/4"	All units	Plum down the top
	*Positioning: (Height) Check the gap at the upper end seam between units	e = ± 1/8"	All units	Check the lationship with the h of T. BHD
	*Connecting parts be-tween units: Check the bevels at seams and bu tts	e = ± 1/8"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Upper Deck	*Positioning: (Length wise) Check shift dimension at butts between upper deck and side shell/L. BHD	e = ± 1/4"	All units	Check the frame space
	*Positioning: (Width) Check the relationship with the ship's center line	e = ± 1/8 "	All units	
	*Connecting parts between units: Check the bevels at seams and butts	e = ± 1/8"	All units	

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
<u>ERECTION</u> F'cle Deck & Poop Deck	*Positioning: (Lenght wise) Check the shift dimensions and bevels at the butts between the deck and shell plates /L.BHD	e = ± 1/4"	All units	Check the space
	*Positioning: (Width) Check the relationship with the ship's center	e = ± 1/4"	All units	Plum down f the top of upper deck
	*Level: (Transverse) Check the knuckle at the pillars and BHD	e = ± 1/4"	All units	Check the s tness both pillars and BHD
	*Positioning: (Height) Check the height at the pillars and BHD	e = ± 3/8"	All units	Check the c nection to er pieces.
	*Connecting parts between units: Check the bevels at seams and butts	e = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Grand Assembly With Stern Frame	*Positioning: (Length wise) Check the dimension from the after end of Main Engine to the af ter end of the Boss	e = ± 3/8"		Shaft length
	*Positioning: (Tran-sverse) Check the center line of the ship from upper gud-geon, lower gudgeon to the center line on the berth	e = ± 1/8"		*Plum down from upper gudgion to lo-wer gudgeon * Plum down fr-om lower gud-geon to the berth
	*Sight seeing of the shaft center: Marking the center at the 3 points on T. Top	e: (Transverse) ± 1.5/16 Height ± 1.5/64"		Measuring by transit
	*Connecting parts be-tween units: -Check the bevels at seams and butts -Fitting to the radius part of the keel plate	e = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Grand Assembly At Cant. Frame	*Positioning: (Length wise) Check the dimension and bevels at the butt	e = ± 1/4"		Check the ame space
	*Positioning: (Trans-verse) Check the relation-ship with the ship's center	e = ± 1/8"		Check the tinuity wi the forwar unit
	*Rudder center: Check the dimensions, trans-verse, and lenghtwise with the upper gud-geon	e = ± 1.5/16"		Check the lationship rudder cen at upper g geon
	*Rudder center: (Hei-ght) Check the dimensions between the flat top and the upper gudgeon	0 ~ 1/4"		Dimension the steeri gear flat to uppper geon top
	*Level: (Lengthwise) Check at the top on the center line	e = ± 1/8"		

SHOP	ITEM	TOLERANCE	FREQUENCY OF MEASURE-ING	REMARKS
ERECTION Grand Assembly At the Bow Construction	*Positioning: (Length wise) Check at the after and frame with plating	e = ± 1/4"		Plum down
	*Positioning: (Trans-verse) Check the relation-ship with the center line on the berth	e = ± 1/8"		Measuring by transit
	*Positioning: (Height) Check the gap at the seams between the unit and afterward unit	e = ± 1/4"		Check with the height of the longitudinals
	*Connecting parts be-tween units: -Check the bevels at seams and butt -Check the connection to the shell plates	e = ± 1/8"		

SHOP	ITEM	ALLOWABLE TOLERANCE	FREQUENCY OF MEASURING	REMARKS
NC Burning Machine	*Check accuracy		5 times/day	
	*Accuracy Check: After marking a square, measuring diagonals		1 time/week	
	*Check gas kerf compensation			
	*Check the discrepancy of positions between the marking equipment and the cutting torch			
	*Check the roughness of the cut surface			
Flame Planer	*Width after gas cutting	e = ± 1/64"	5 times/day	
	*Roughness of cut surface		5 times/day	
	*Bevel angle		5 times/day	

BASE LINE TO BE EFFECTIVE FOR KEEPING HIGH ACCURACY INCLUDED IN TEE OUTPUT THROUGH ENGINEERING AND LOFTING

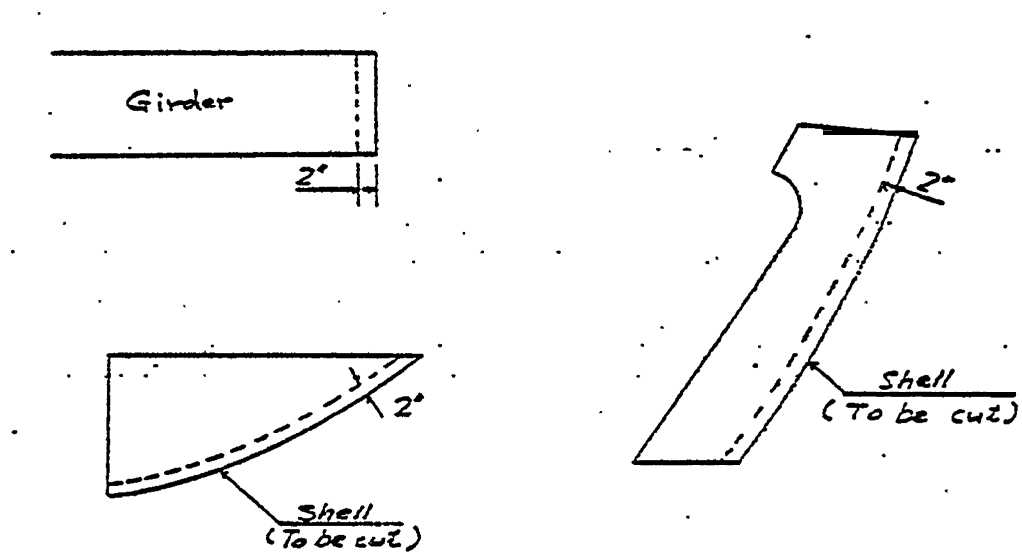
(1) Checking line for gas cutting.

A preciously marked parallel line to a cutting line is useful *to* check how precisely gas cutting has *been* done. The distance between said two lines are fixed, 2 inches for example, so precision of gas cutting can be easily checked by *measuring the* distance after cutting.

This line is particularly useful for the following parts:

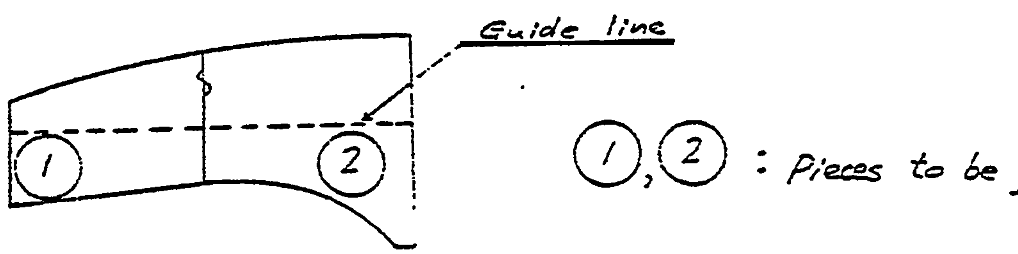
* Joint part of the griders

* Edge line *to* curved shell



(2) Guide line for plate joining at sub-assembly

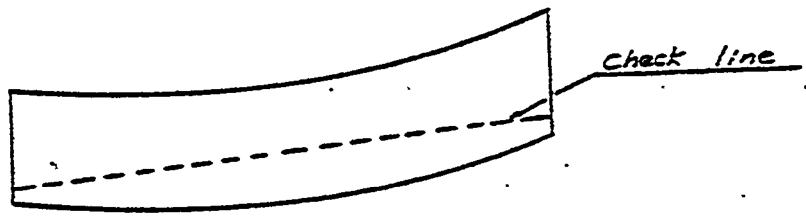
In case of joining two pieces which have no long straight surface at sub-assembl
a previously marked *straight line passing through both* pieces
these pieces on the correct position.



REF. No. KCT041

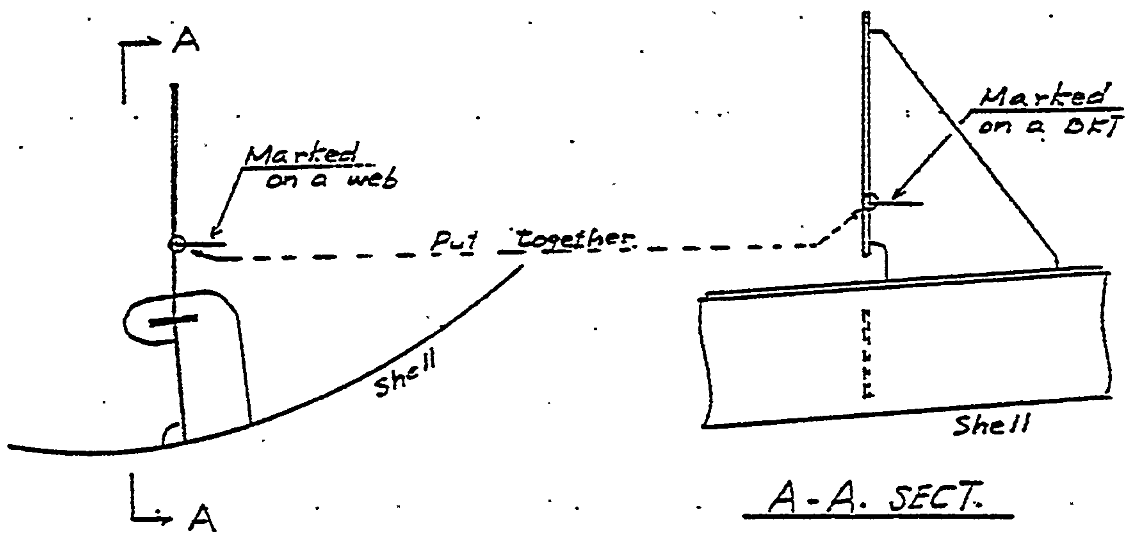
(3) Check line for torsion by heat

In case of a long and narrow piece without any appropriate straight line, a previously marked straight line is useful to check how much distorsion has been caused by heat during gas cutting and also useful as a guide line to reform; reforming is continued untill the marked line becomes straight.



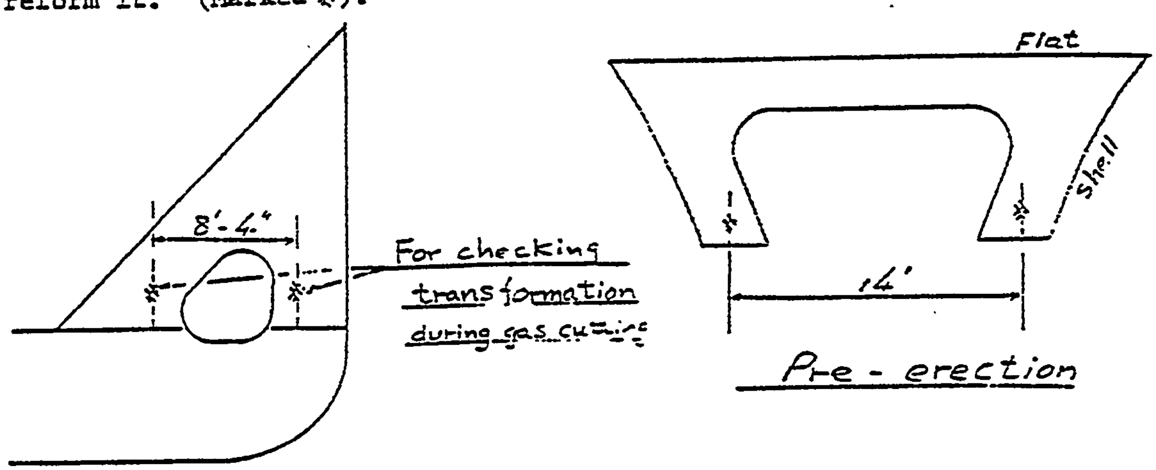
(4) Guide line for fitting stiffeners (BKT, FB) on a web.

In case that the end point of a stiffener is not clear; a stiffener stops at a longitudinal frame and a "cutout" is opened there, for example; both marked lines on a web plate and on a stiffener itself are very useful to fit a stiffener on a web by putting one line on another.



(5) Check line for keeping a certain dimension.

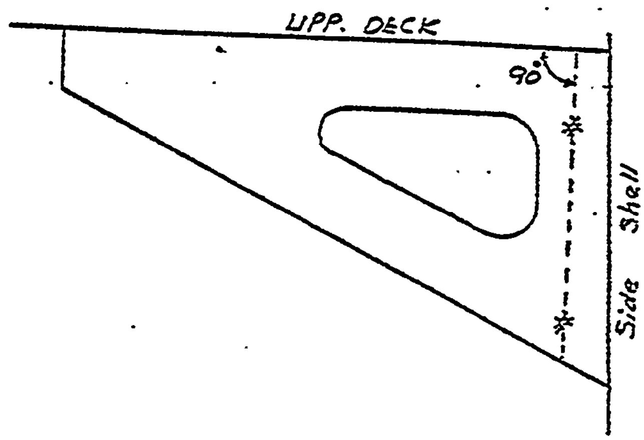
In case of the following drawings, two parallel lines apart a certain distance each other are useful to check transformation of a piece and/or a unit and to reform it. (Marked ※).



6) Check line for shipwright

In case of the following drawing, a previously marked normal line to upper deck is useful to check shipwright of top side unit at assembly. Shipwright is easily checked by some methods such as a plummet.

(Marked ※)



STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume II

- Accuracy Control of Hull Construction -

Addendum

October, 1979

IHI

Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

ACCURACY CONTROL

ADDENDUM FOR IHI'S FIRST SURVEY REPORT

AND FIRST RECOMMENDATION

TO NASSCO

October, 1979

Ishikawajima-Harima
Heavy Industries Co., Ltd.
TOKYO JAPAN

REF. No.

CONTENTS

Summary

This document was prepared by IHI as the addendum for the first survey report and the first recommendation which were already furnished to NASSCO.

After the first survey on the present Accuracy Control System at NASSCO lasted from May 7, 1979 through May 18, 1979 NASSCO was visited again by two (2) IHI engineers to clarify their findings with some effective recommendations and to assist implementing the advanced Accuracy Control System at NASSCO. The implementation was done from August 6, 1979 through August 31, 1979 in the following schedule:

1) The actual implementing schedule

* August 6 - 8

  IHI briefly explained IHI's first survey report and the first recommendation to the manegements and the nominated experts of NASSCO to confirm that description and to review the present status at NASSCO.

* August 8 - 14 (5 days)

  Detailed explanation of the all documents, prepared by IHI to the experts group of NASSCO.

* August 15 - 16

  Brief explanation of the said report and recommendation to the group of formen of NASSCO.

* August 17

IHI conducted to design the unit assembling method and data sheet for a flat unit under assembly.

* August 20 - 21

IHI conducted to gather necessary data and designed dimensions to compare with the actual dimensions. Then measured the actual dimensions along the data sheet.

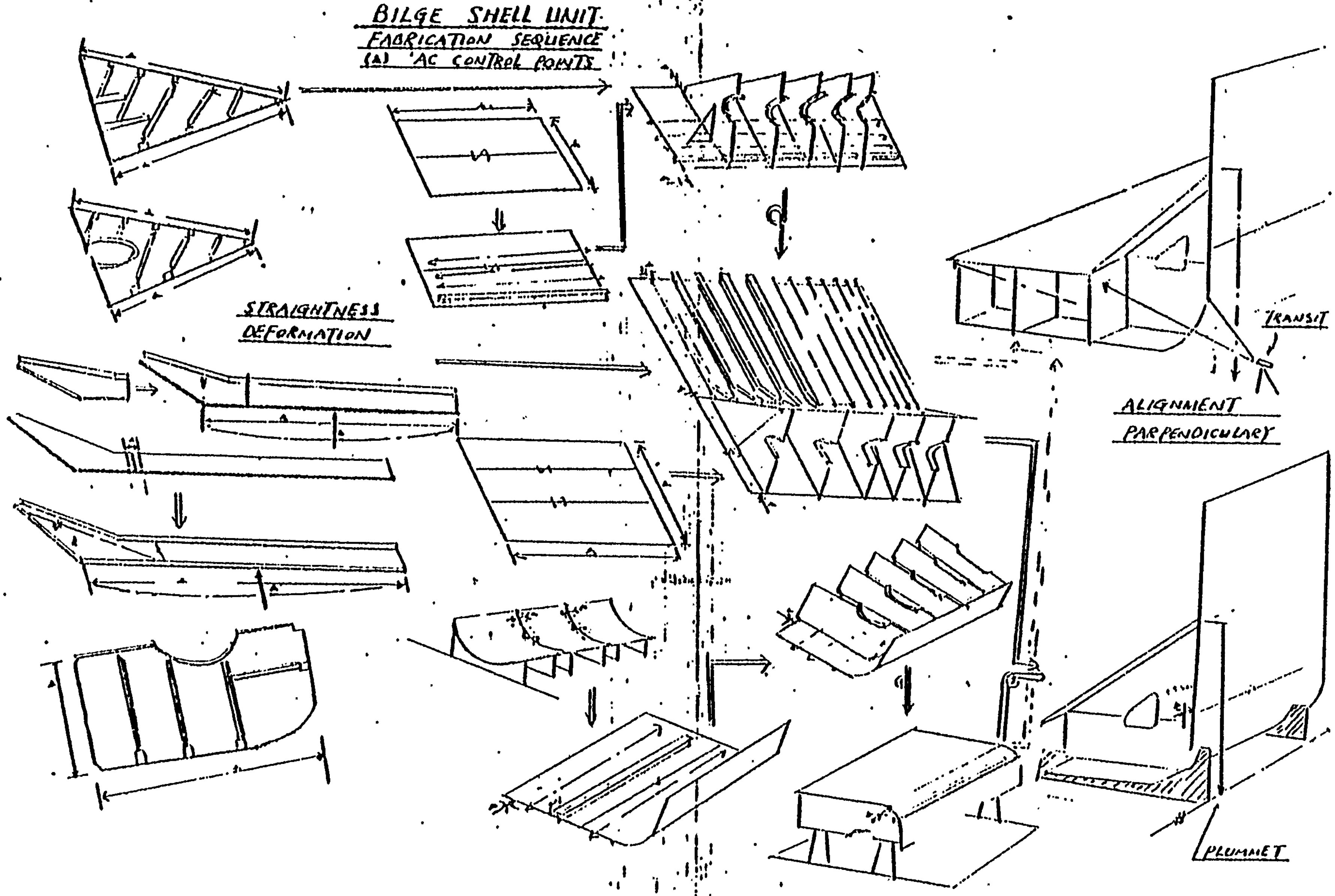
* August 21 - 22

IHI conducted to analyze the measured dimensions referring to the IHI's method described in the report.

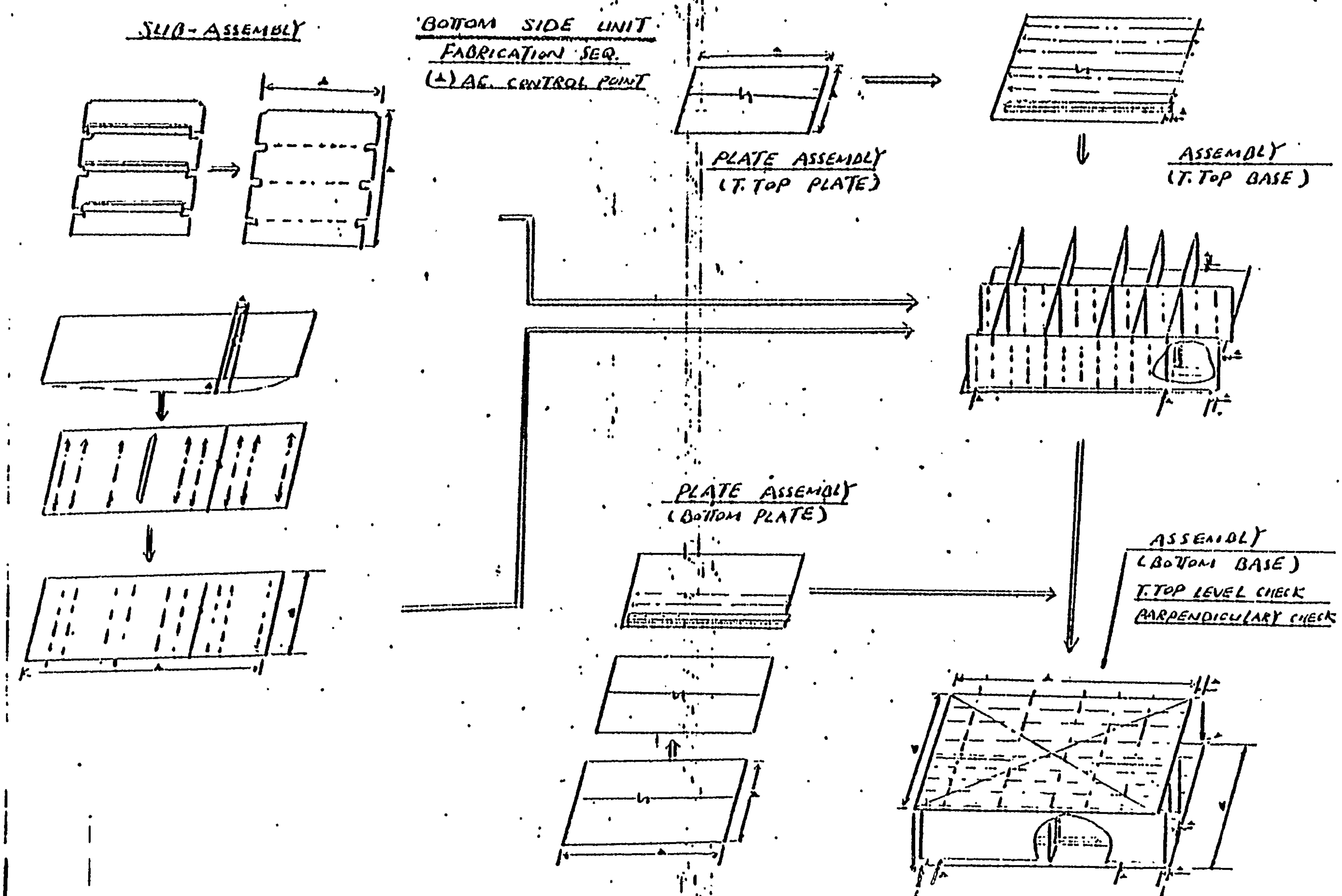
* August 23 - 31 (7 days)

IHI conducted to apply to a curved shell unit under assembly in the same manner as the flat unit. And IHI assisted the experts group of NASSCO to prepare the recommendation to the top management on this subject.

Thus, after explanation of IHI's first survey report and the first recommendation, a typical method was applied to a few real units under assembly to test the A/C techniques written in that report. This method along with further recommendations for accuracy control implementation at NASSCO is presented hereafter. Since there is not a written standard at NASSCO, recommendations and discussion of the standard itself are excluded.



BILGE SHELL UNIT
FABRICATION SEQUENCE
(A) 'AC CONTROL POINTS
STRAIGHTNESS
DEFORMATION
TRANSIT
ALIGNMENT
PARPENDICULARY
PLUMMET


SUB-ASSEMBLY
BOTTOM SIDE UNIT
FABRICATION SEQ.
(▲) AC. CONTROL POINT
PLATE ASSEMBLY
(T. TOP PLATE)
ASSEMBLY
(T. TOP BASE)
PLATE ASSEMBLY
(BOTTOM PLATE)
ASSEMBLY
(BOTTOM BASE)
T.TOP LEVEL CHECK
PARPENDICULARY CHECK

One of the ways in which this scope can be reduced is by "Grouping." For example, the installation of fuel oil piping in the Engine Room can be broken down as follows:

Marking pipe line
Installing piping
Fastening pipe flanges
Welding pipe supports
Installing valves
Fastening pipe supports

Also, this sequence can be described simply as:

Installing firemain piping

The former is referred to as "description of elemental jobs" or "elemental jobs" and the latter as "description of grouped jobs" or "grouped job." Six elemental jobs become one grouped job.

In this particular case, the "grouping" means "grouping jobs." On the other hand, looking at materials included in the elemental jobs, we can find that a description of material can represent a job description relating to that material. In this report, "grouping" is mainly grouping materials, and "palletizing" means "grouping of materials."

Note: Sometimes the word "pallet" is used for "grouped materials" or for the physical container, which is usually made of steel, and by which the grouped materials are transported.

3. Resources of Palletizing

In the outfitting production process, there are many resources to be controlled. They can be JOB, MATERIAL, PERSONNEL, TIME, MONEY, etc. Since time and money are the results of control, we can omit them from our discussion.

Material is always closely related to job. For example, "MATERIAL," a main engine, produces "JOBS" such as loading onboard, installation, fuel oil piping, electric wiring for automation, operation, testing and painting.

At the same time, "MATERIAL" has a relationship to "PERSONNEL" through "JOBS." That is, "MATERIAL," a main engine, requires a number of riggers for loading onboard, machinists for installation, pipefitters for fuel oil piping, electricians for electric wiring for automation, and so on.

In addition to the above, "MATERIAL" is always definite and concrete throughout all the production phases – design, material procurement, planning, scheduling, manufacturing, assemblying, installing, testing, operation, etc. "MATERIAL" is always visible, therefore everybody can easily tell if something is wrong. For example, the pipe is not strong enough for the test pressure, shipping of the fresh water pump is delayed, installation of the condenser has to be started, etc.

The above facts suggest that if we can control the flow of materials, the other entities can automatically be controlled. So we finally decide that "MATERIAL" is the major resource of grouping.

4. Planning Palletizing

4.1 Introduction

What will be the best method of palletization? We have already discussed that material is the best among the possible resources for outfitting job control. But how are we to palletize (group). material —— system-by-system, zone-by-zone, trade-by-trade, stage-by-stage, or a combination of the above?

The three dimensional illustration of the concept of palletization — conventional and improved — show the differences between the two ideas for three axes of function, zone and time, as shown in Fig. 1-7.

Note: Function relates to trade.
Time relates to stage.

The size of pallet is also important in planning. Size must be determined by the following considerations, as shown in Fig. 1-8:

1) Large number of pallets makes a network and control complex.
2) Large yard facility allows *large* size pallet.
3) Large size of ship requires large number of pallets.
4) A Ship which has complex outfitting requires larger number of pallets. In other words, an LNG tanker requires more pallets than does an oil tanker.
5) Pallet segregation relates to hull block segregation.

CONCEPT OF PALLET

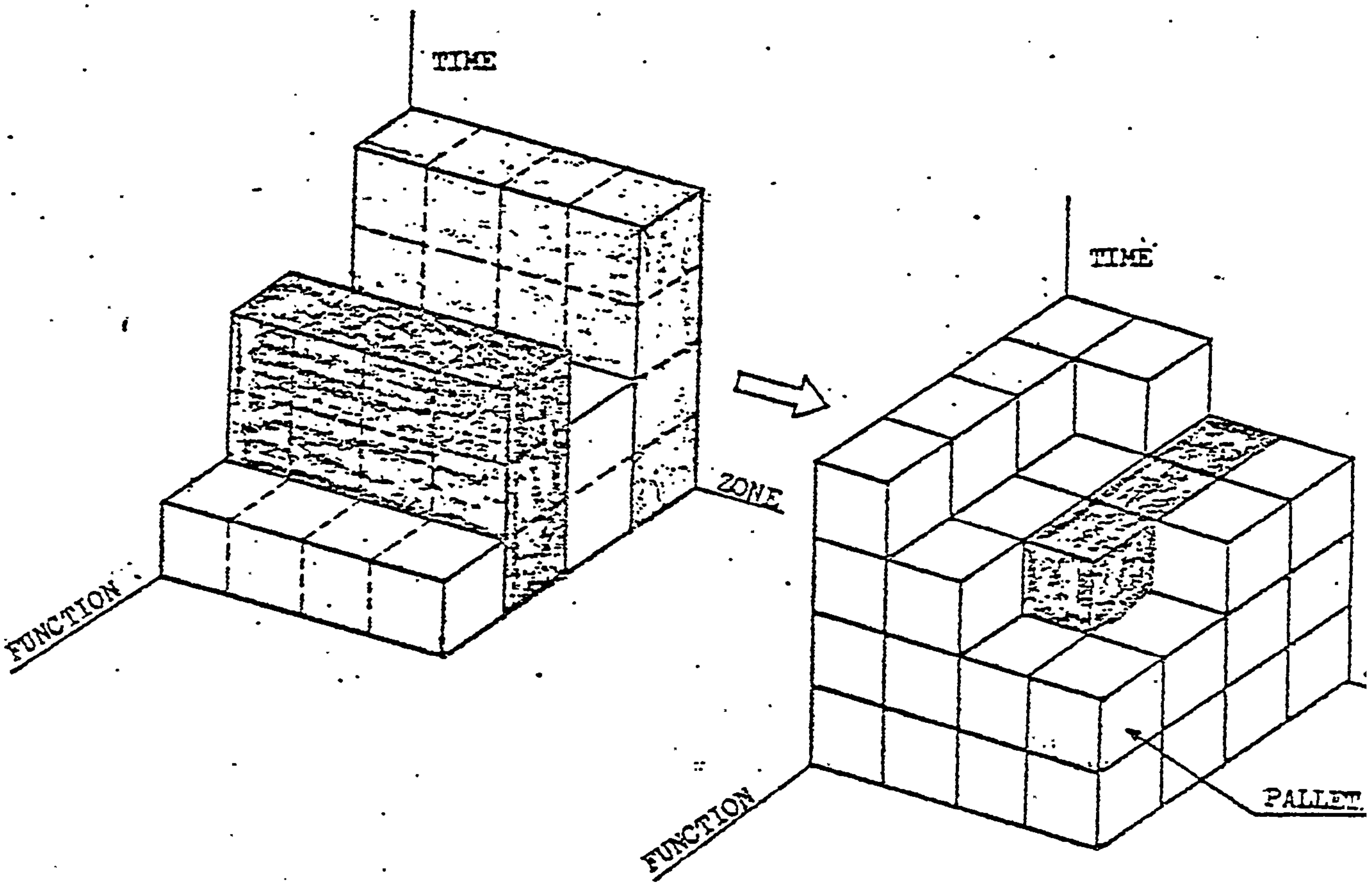


Fig. 1-7

- Size of Pallet
  - Most suitable for control
    - The suitable size is decided by:
      - Yard facility
      - Size/type of ship
    - The size depends on
      - Hull block segregation

Average No. & Size of Pallet/Unit at IHI Kure Shipyard

Number			Size
	Freedom	250 Tanker	Max. Unit Size
Accom.	450	400	30 L x 20 B x 10 H
Dk & Hold	300	800	(hull block size)
Machinery	250	400	Max. Weight
Electricity	200	300	275 Ton
			(hull block weight)
Total	1200	1900	

Fig. 1-8

Size of Pallet

Most suitable for control

The suitable size is decided by:

Yard facility

Size/type of ship

The size depends on

Hull block segregation

Average No. & Size of Pallet/Unit at IHI Kure Shipyard

Number			Size
	Freedom	250 Tanker	Max. Unit Size
Accom.	450	400	30 L x 20 B x 10 H
			(hull block size)
Dk & Hold	300	800	
Machinery	250	400	Max. Weight
Electricity	200	300	275 Ton
			(hull block weight)
Total	1200	1900	

Fig. 1-8

- The number of managing activities becomes great. They have various durations and create complicated networks.

- The complicated network causes poor control and poor feed back due to its great number of objectives.

- The system oriented network causes idle time due to the difficulty of synchronizing work order releases for various activities. (See Note 1.)

- Installation jobs have a tendency to be scattered over a ship.

- Schedule is dependent on hull schedule.

Note 1: See Chapter I, 5. "Efficiency of Outfitting Jobs"

4.3 Palletization by Zone

If we can forget that all materials belong to certain systems and establish that they only belong to some zones where they are to be installed or that they are only parts composing a ship but equally divided into zones, and if we have a drawing that indicates the procedures for installation of a particular system, it is not necessary to take special care for particular system installation.

Fig. 1-9

Zone Outfitting on-block (F'cle Bosun Store)

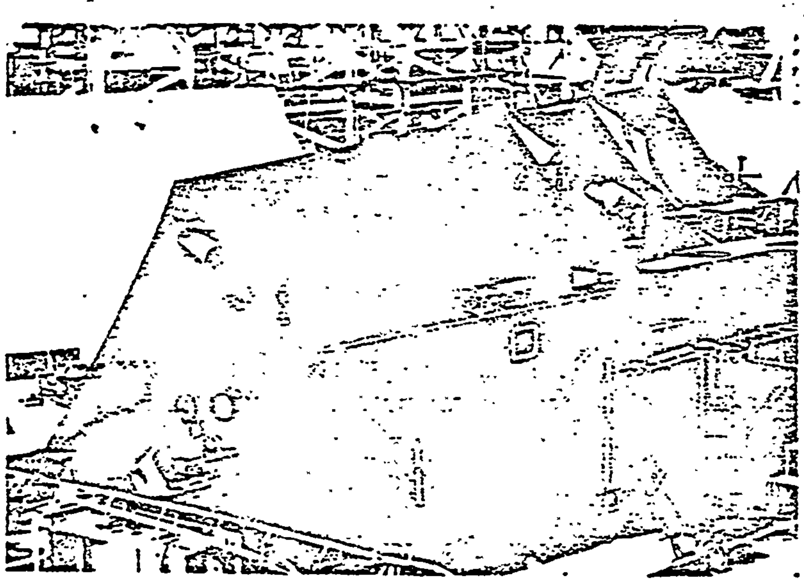


Fig. 1-10

Zone Outfitting on-block (Engine Room Side Shell)

Fig. 1-9

Zone Outfitting on-block (F'cle Bosun Store)

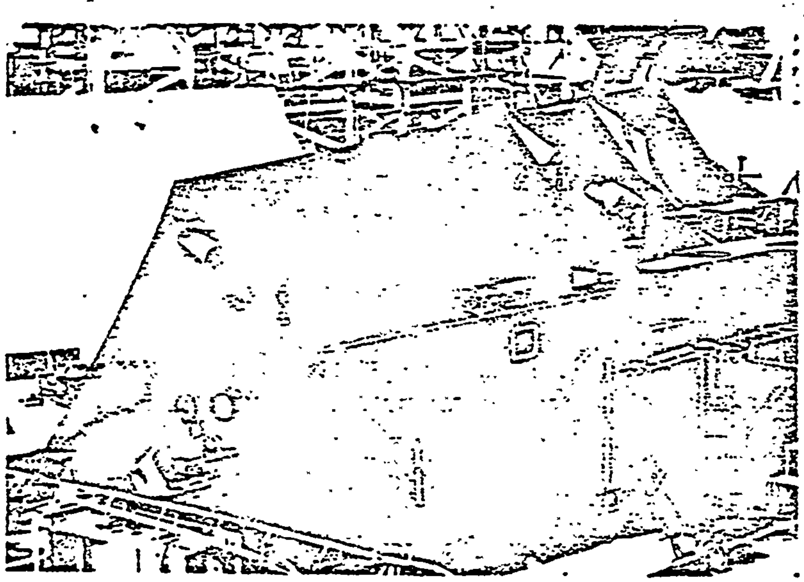
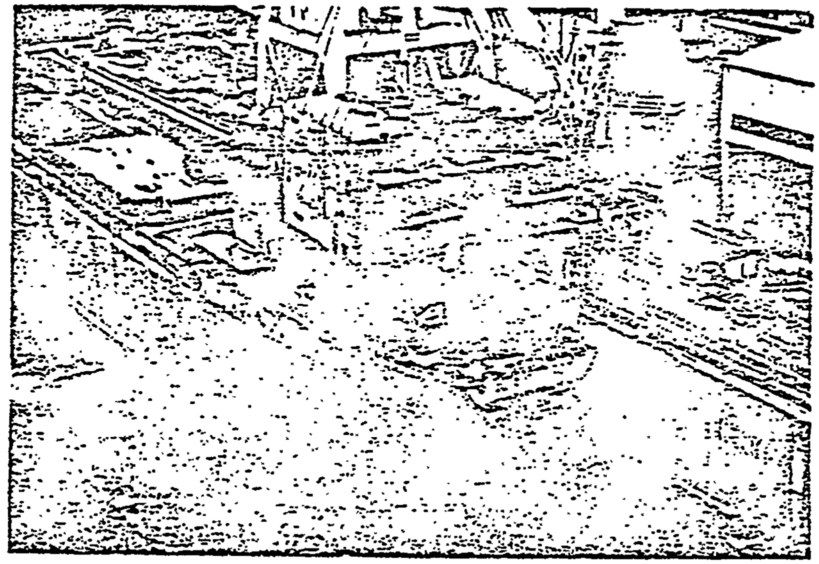


Fig. 1-10

Zone Outfitting on-block (Engine Room Side Shell)

Fig. 1-11



Erection of Outfitted Superstructure
(Grand Block of Accommodation with Engine Casing,
Looking Forward)

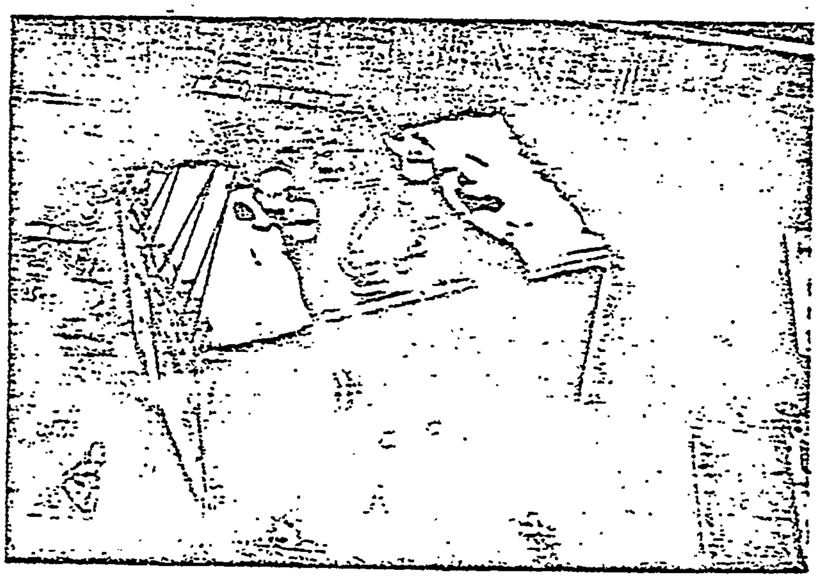


Fig. 1-12

Erection of Outfitted Superstructure
(Grand Block of Accommodation with Engine Casing,
Looking Aftward)

4.4 Grouping by Trade

Materials palletized by zone can further be grouped by trade.

They belong to various functional systems which require particular knowledge and skill for installation. But if the knowledge and skill are completely instructed in drawings, outfitting jobs become simply installation of material. IT requires a worker to have simple abilities such as reading drawings, installing materials as shown in drawings, fastening bolts and nuts, welding, etc. This means that every worker has an opportunity to perform all kinds of outfitting jobs. If this opportunity is realized, both system and activity loss could be reduced.

Actually, however, we still need some.specialties for installation of different system Subdividing materials by specialties is still providing us good productivity. Although, too *many* subdivisions results in too many activities, which would **cause low system** efficiency (*1) Therefore, subdivision has to be optimum.

(*1) See Chapter I, 5 "Efficiency of Outfitting Jobs".

Possible breaksdowns for palletizing by trade are:

Pipefitter

Steelworker

Machinist

Carpenter

Electrician

Automation installation group

Operation & adjusting group.

Each group has to have the ability *to* perform welding.

Pipefitters have *to* be able to install-not only. pipes but also pipe supports and materials which are closely related to piping.

Steelworkers have to be able to install ducting, gratings, handrails, cranes, ladders, doors, buits,- bollards, racks, foundations for machinery, etc.

Machinists have to be able to install and adjust machinery.

Carpenters have to be able to *install* not only steel and wood furniture but also lines, ceiling, furring, joiner doors, racks, almost everything relating to accommodations.

Electricians have to be able to install not only electrical equipment and wiriing but also supports for wirizing and everything relating to electricity.

Automation installation groups have *to* be able to install tubing, wiring, equipment and *other* things relating to automation.

Operation and adjusting groups have to be able to perforn everything relating *to the* operation of machinery.

Fewer trades means *fewer* activities. Fewer activities in *a* network makes the loss less.

4.5 Grouping by Stages

Materials in one zone can be further divided into several groups which can be installed at different times. Some of these can be installed while they are being assembled in the shop. Some others can be installed after the ship is launched.

The former, installation in shop, provides better productivity than the latter because a shop provides adequate facilities, tools, safety and convenience in material handling and transportation, protection from the weather and ease of supervision. Even if pipe pieces have to be installed on both sides of a deck structure, both can be installed so that piping is not on the underside of the deck plate but on the upperside. We can avoid difficulties such as lifting heavy things overhead and welding in overhead positions. Such installations can be performed each time the deck structure is turned over.

Stages combined with hull and outfitting can be divided into several steps as illustrated in Fig. 1-13.

Manufacturing

This means manufacturing process in the shop of pieces which are listed in the "Material List of Pallet." But since the procedure for piece manufacturing is quite different from that for outfitting, it has to be controlled independently. Therefore, a necessary aspect is timing, to meet both completion of pieces and starting of palletization.

Unit Assembly (Fig. 1-4, 1-14, 1-15)

This means the assemblying process of a unit, which consists of machinery, foundations, piping, *valves, and any. othe* rials closely located, that are assembled firmly, sometimes reinforced, to allow transportation and installation *as* one piece. An advantage of this process is that it can be done in the shop, which provides superior conditions to the outside shop .

On-block Outfitting (Figs. 1-9 and 1-10)

This means a process of installation for pieces and units on hull block, in the shop or on land. It is usually carried out while hull blocks are being stored, but also can be done while they are being assembled. Its advantage is the same as *that of* unit assembly.

Onboard Outfitting

This is a process of installation for pieces and units onboard the ship. Installation of pieces and units which are already installed on-block is carried out at the same time *that* the block goes to erection onboard. Combinations of these pro*cesses" results* in 4 procedures for outfitting jobs. They are illustrated *on Fig.* 1-13.

WORK FLOW OF PALLETED MATERIALS

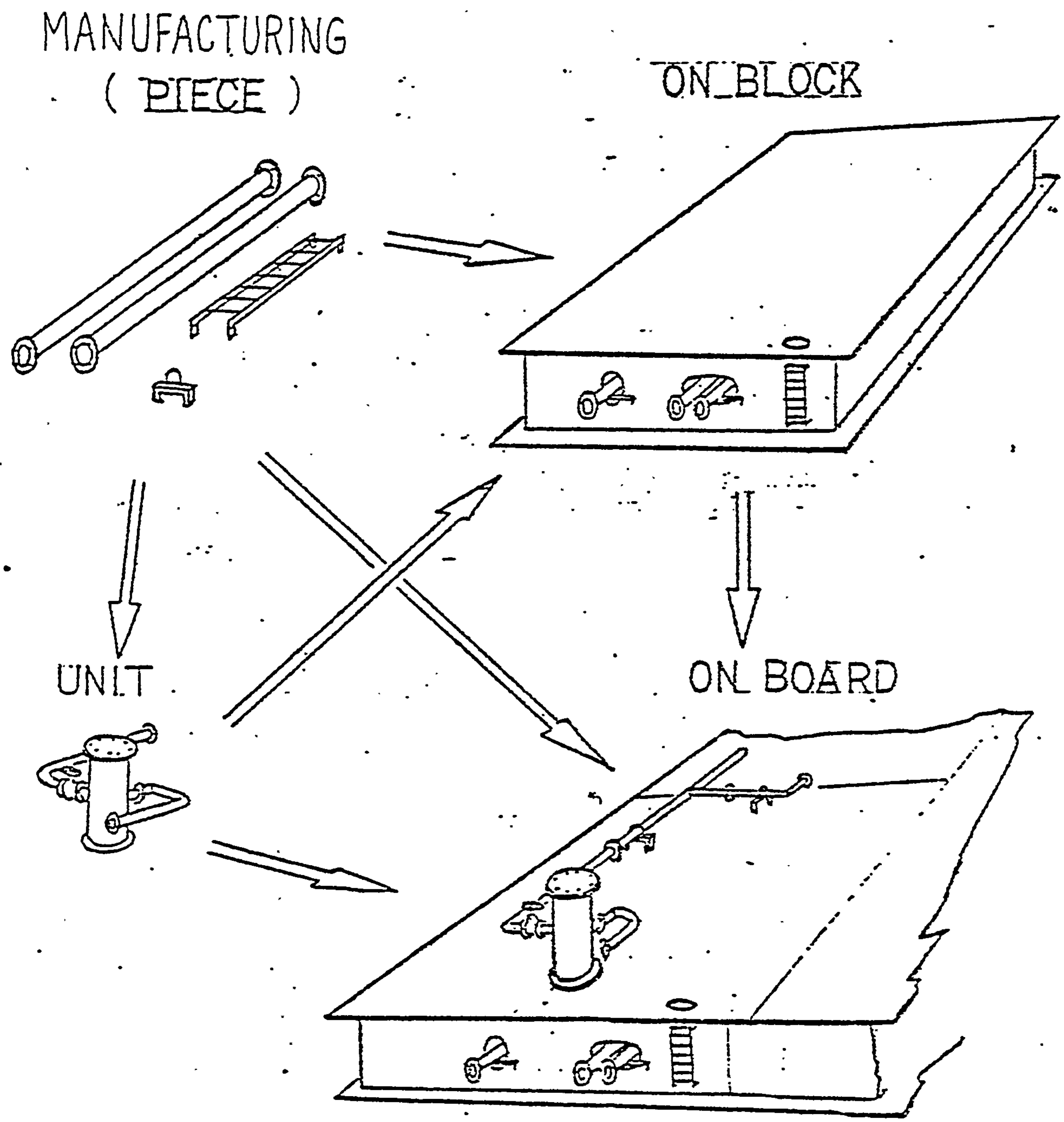


Fig. 1-13

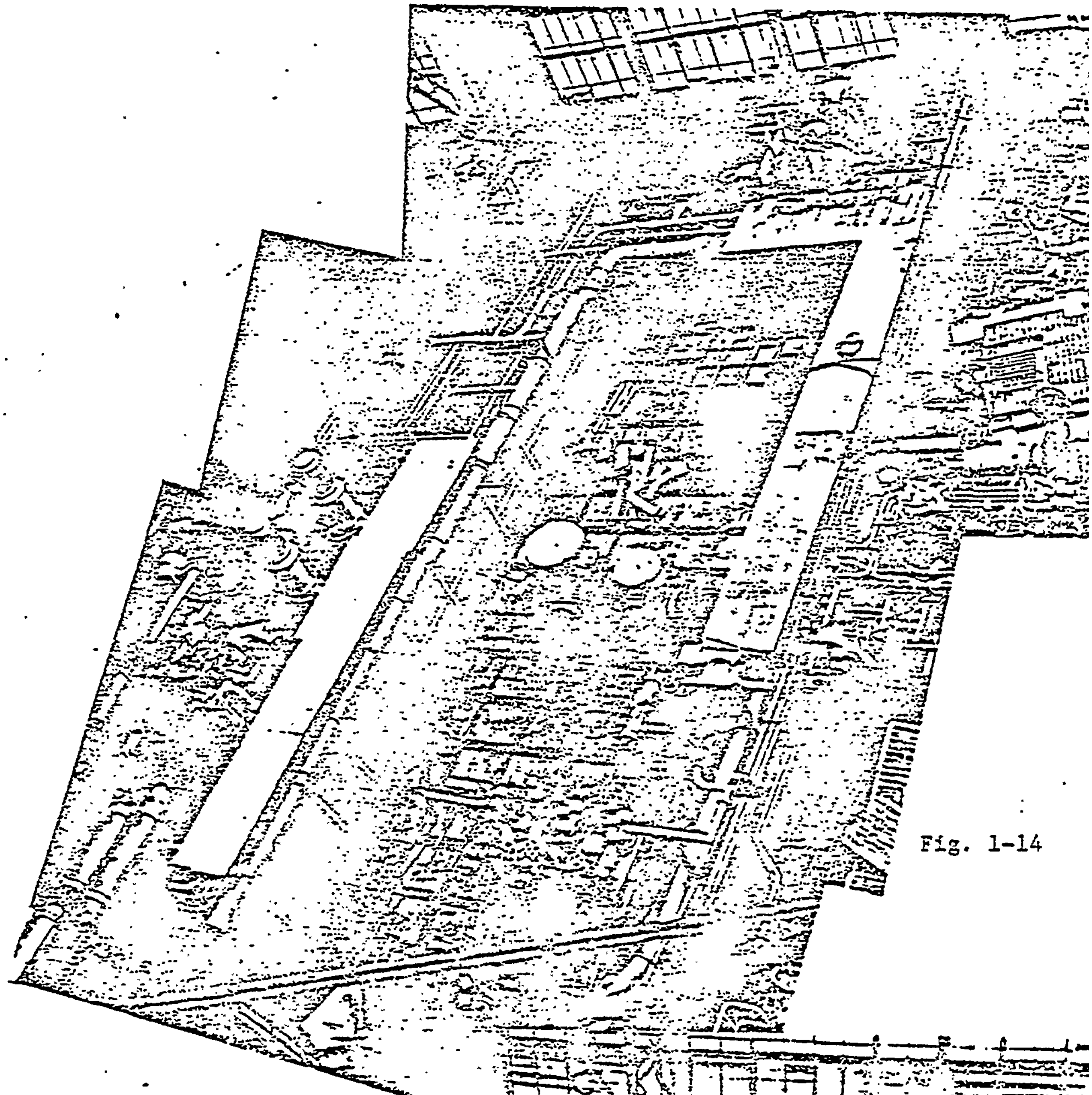


Fig. 1-14

Fig. 1-15

4.6 Manufacturing of Pallet

1) Required ***quantity*** of Pallets

The fact or for determination:

Daily products of pipe shop	A pcs/day
Average contents of one pallet	B pcs
Average stay period in shop	c days

Required quantity of pallets = (2A/B)C

(including materials other than piping)

2) Pallet Design

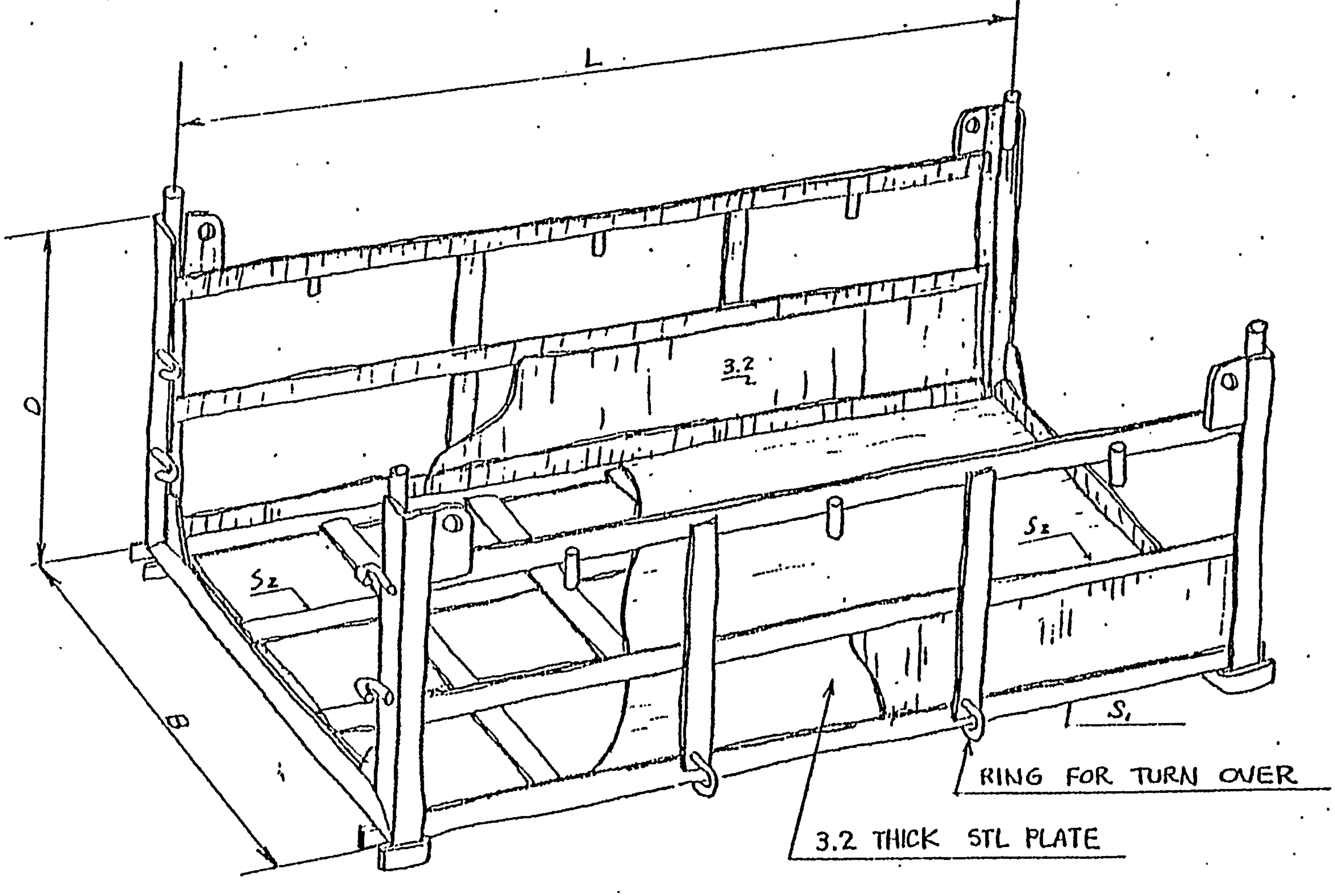
Presented IHI case. (Fig. 1-16)

- Size of pallet; As shown-in Fig. 1-16
  (provided the quantity of pipes is 50 pcs in maximum
  average quantity can be assumed about 30 pcs.)

- Material for pallet; angle bar 3" x 3" X 3/8", steel net,
  lifting eye plate, rib, etc.

unit: mm

	L	B	D	S1	S2
Large Pallet	1,922	900	805	75 x 75 x 9	75 x 9
Small Pallet	3,400	1,800	1,800	100 x 100 x 10	90 x 60 x 9 ⊥



5. Efficiency of Outfitting Jobs

Efficiency of outfitting jobs can be divided into two categories. One is called "system efficiency" and the other "activity efficiency". When whole outfitting jobs *are* figured out *as-a* network, the former is an efficiency caused by idle time between different activities and the latter-within an activity. Both efficiencies are shown in Figs. 1-17 and 1-18.

5.1 System Efficiency

On the network shown in Fig. 1-17, at *the* point that activities 1, 3 and 4 are connected we sometimes have idle time after completion of activity 1 due to *delay* of activity 3. This idle time W_{lb} is indicated by a *dotted be in* Fig. 1-17.

For example, when activivity 3 is installation of a bilge pump and *activity 1* is pipe fitting for the pump, the pipefit have to delay starting their job until the bilge pump installation is completed. But as we have experienced many zation of different activities is difficult. '

It is inevitably interrupted. Receipt of the bilge pump in the warehouse could be delayed by accident or damage in transportation, or by delay of vendor's delivery. Piping installation would be delayed by problems such as illness of the workers or bad weather etc.

Sometimes, same type of delay occurs before *starting* jobs. (' Workers might be awaiting delayed materials or preparation of tools which should have been prepared in time by another group . This kind of time loss is comparatively larger than time loss caused within an acitivity. This is not a loss caused by workers, but by a network and its control. We can improve this by *improving* the network and improving *control.* We call this "system loss" and efficiency caused by system loss is called "system efficiency."

5.2 Activity Efficiency

Activity efficiency can be divided into two parts. One relates *to* actual work efficiency and the other to personal efficiency.

Actual work efficiency relates to, for example: welding speed, gas cutting speed, grinding speed, fastening speed, etc. It can be improved by technical development for tools, facilities equipment, etc.

Personal work efficiency *relates* to workers' irregular rests during duty that are necessary to continue the *work* physical-ly, such as going to the restroom, etc. It can be improved by providing education, motivation, promation, supervision, etc.

5.3 Palletizing and Efficiency

As discussed, there are many activities in a network. Each activity has the possibility of causing the system problems.

But, if we can reduce the number of activities we could reduce system losses at once. If we can reduce the number by one-teeth could reduce *system* losses by more than one tenth. See Chapter 1; 2.1.

$$\eta_s = \frac{MH - Wn}{MH} \times 100(\%)$$

η_s : System Efficiency

MH : Total Manhour required for System

$Wn = Wna + Wnb$

Wna : Loss before Starting of Work

Wnb : Loss after Work

Fig. 1-17

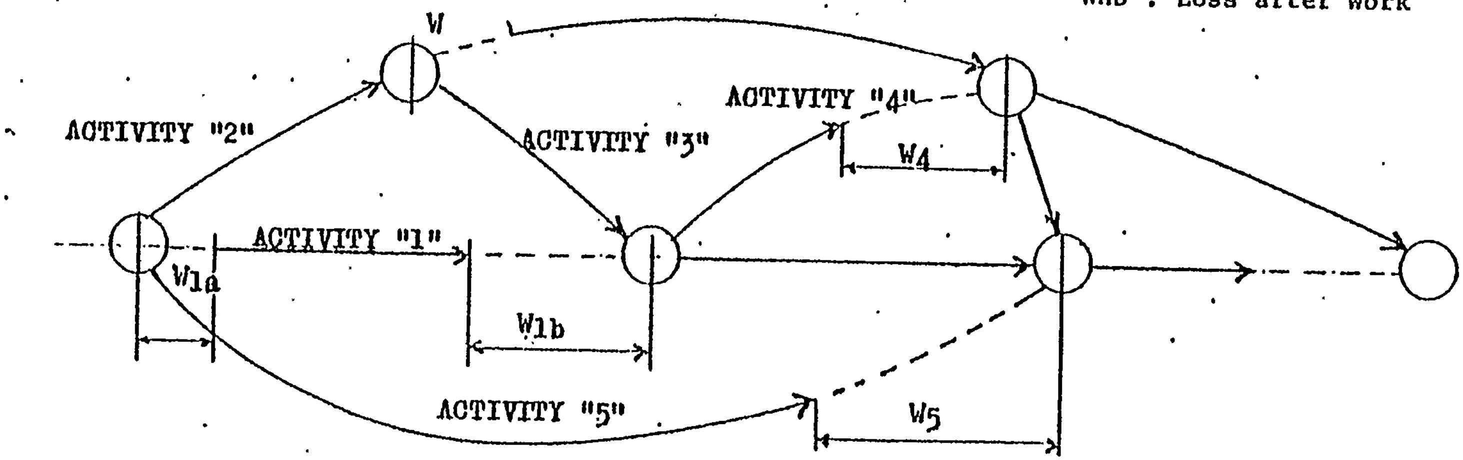
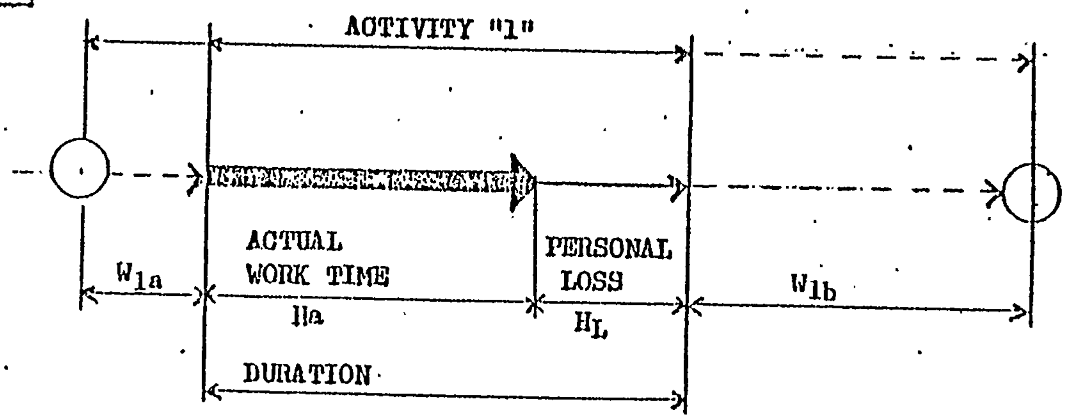


Fig. 1-18



$$\eta_a = \frac{Ha}{Ha + H_L} \times 100(\%)$$

ηa: Activity Efficiency

CHAPTER **II - PROCESS OF PALLETIZATION**

1. Outline of Process for Palletization (Fig. 2-1)

There *are two important* functions involved in establishihg a successful palletizing system: composite drawing and cross-communication between design engineers and production planning scheduling and controlling engineers (PP'S engineers.). . See Fig. 2-2.

After completion, functional drawings (general arrangement, machinery arrangement, piping diagram, ducting diagram, mooring arrangement, access plan, handrail and grating, accommodations, ceiling and living, insulation, etc.) *are* sent to PPS engineers. And then, follow the following procedures.

1.1 **Planning** of Outfitting Method.

PPS engineers study these drawings and decide how to outfit the ship based on their experience on previous ships. They also refer to the hull construction method and hull block segregation. Master schedule (annual schedule) and slip. ways or docks *to be* used are also referred to.

Finally, the PPS engineers decide outlines of how to outfit the ship and a list of pallets which will be used in that particular ship. They also devise a pallet schedule which shows the required date of each pallet. (See detail e-xplana-

tion in Chapter II, 4.2.) This information is then sent to design engineers.

1.2 Preliminary Composite Drawing

Design engineers *study* the above information and develop pre-liminary composite drawings, which are very *rough* arrangements of piping, ducting and other major equipment on the general and machinery arrangements. Piping is indicated by only one line, as in a diagram. But the drawing has to be developed so that PPS engineers *can* understand how many and what kinds of pipes will be run in a particular section, and then they can decide palletizing segregation for almost all materials, relating to zones, trades, stages and units. See Fig. 2-3.

Preliminary composite drawings are sent to PPS engineers for their review.

1.3 Scheduling of Material Procurement

The pallet list and *its schedule are sent to m* *engineers.* They decide the material purchasing and issuing schedules, referring to the lead-time of materials. See Figs. 2-4 and 2-5.

1.4 Review on Preliminary Composite Drawing

Preliminary composite drawings are reviewed by PPS engineers, together wish design engineers. They plan palletizing. They decide what materials are to be installed at the assembly *stage,* onboard the ship, or assembled into units.

This information is sent back to the design engineers.

1.5 Developing Composite Drawing

Design engineers develop composite drawings, referring to functional drawings and information from PPS engineers. Composite drawings are drawn zone-by-zone. *All materials* that are to be installed in *a* zone have to be indicated after checking that they have no interferences with each other. Besides *necessary* information for installation being indicated in these drawings, they are also satisfied by functional requirements.

After completion, composite drawings are sent to PPS engineers.

1.6 Review of Working Drawing

Composite drawings are reviewed by PPS engineers to see if the drawings reflect the intended installation. IF they have any comments on these drawings, they discuss their comments with design engineers until both PPS and design engineers reach mutual agreement.

Then, approval for further development is then given on those drawings.

1.7 Development of Working Drawings

Working drawings are drawings by which installation of material in one zone can be completed. A drawing is issued with segregation corresponding to one activity, that is, *issued by* zone, by trade and by stage. Sometimes it is issued with more than one segregation for convenience in installation ***or*** manhour saving. Contents are almost the same as those of ***a composite*** drawing, thesefore, it can be developed from the composite drawing by means of a photographic technique.

A material list of pallet is made from the working drawing. Both working drawings and material **lists** are sent to PPS engineers for planning, scheduling and actual jobs. Material lists are sent to *material* control for updating the material ledger and palletizing.

Note: A working drawing is issued only when outfitting in a *certain* zone is congested as not to be covered by the composite drawing. Normally the composite drawing can be used as working drawings.

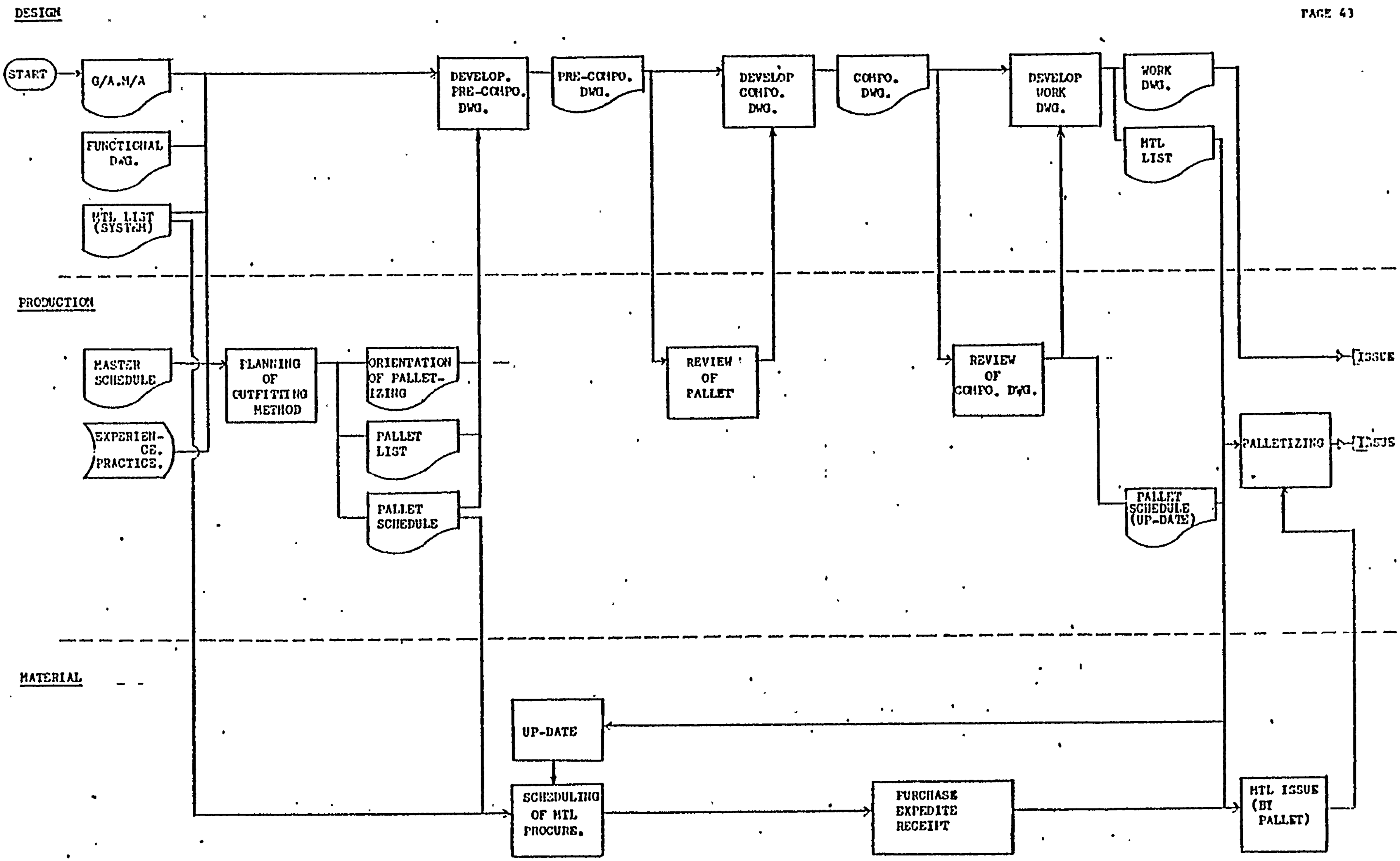


FIG. 2-1

Fig. 2-1 PROCESS OF PALLETIZATION

A-B-C-D meeting

A-B-C-D meetings are held for cross communication between Sales, Initial Design, Yard Design and Production.

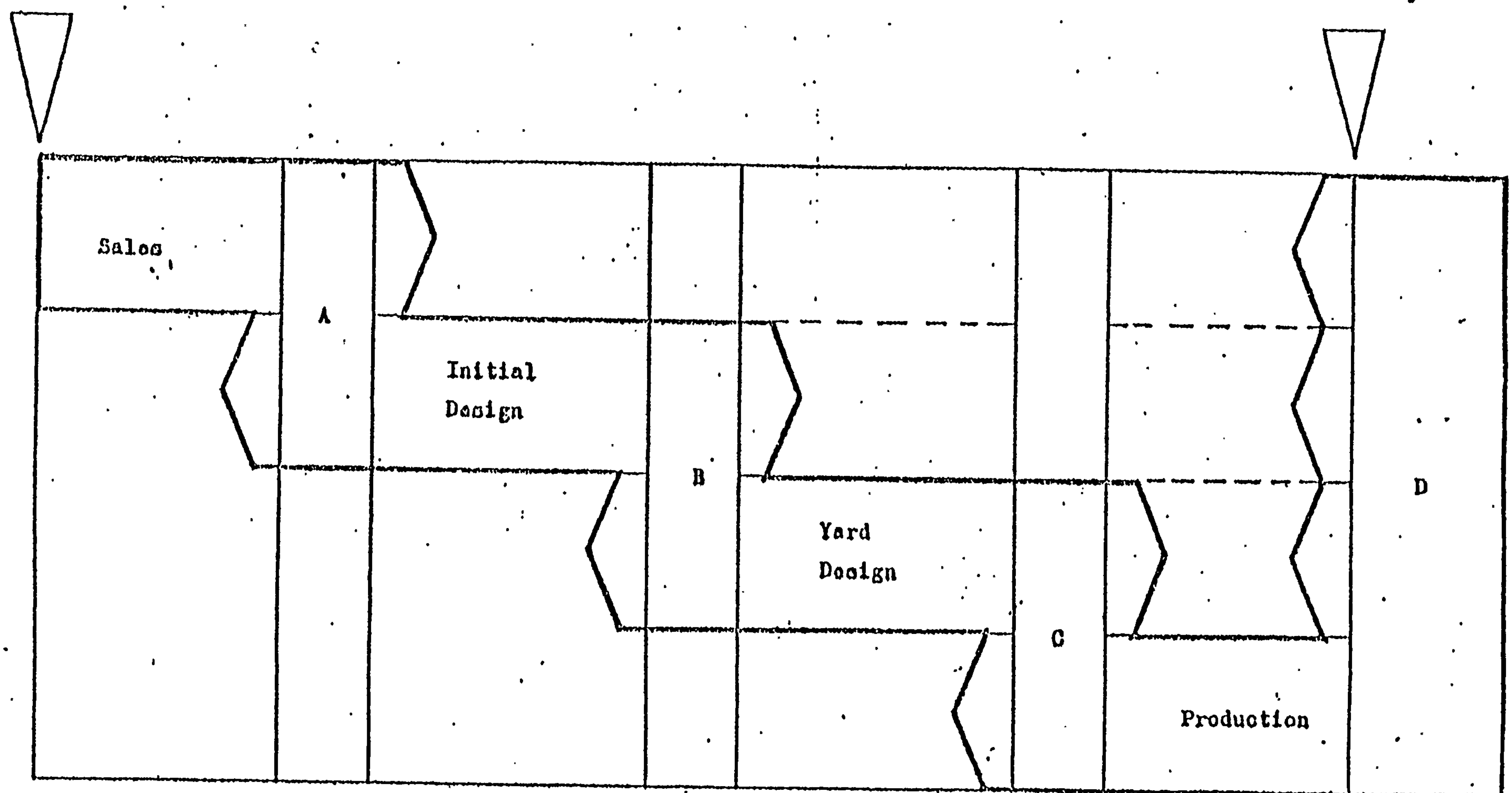


Fig. 2-2

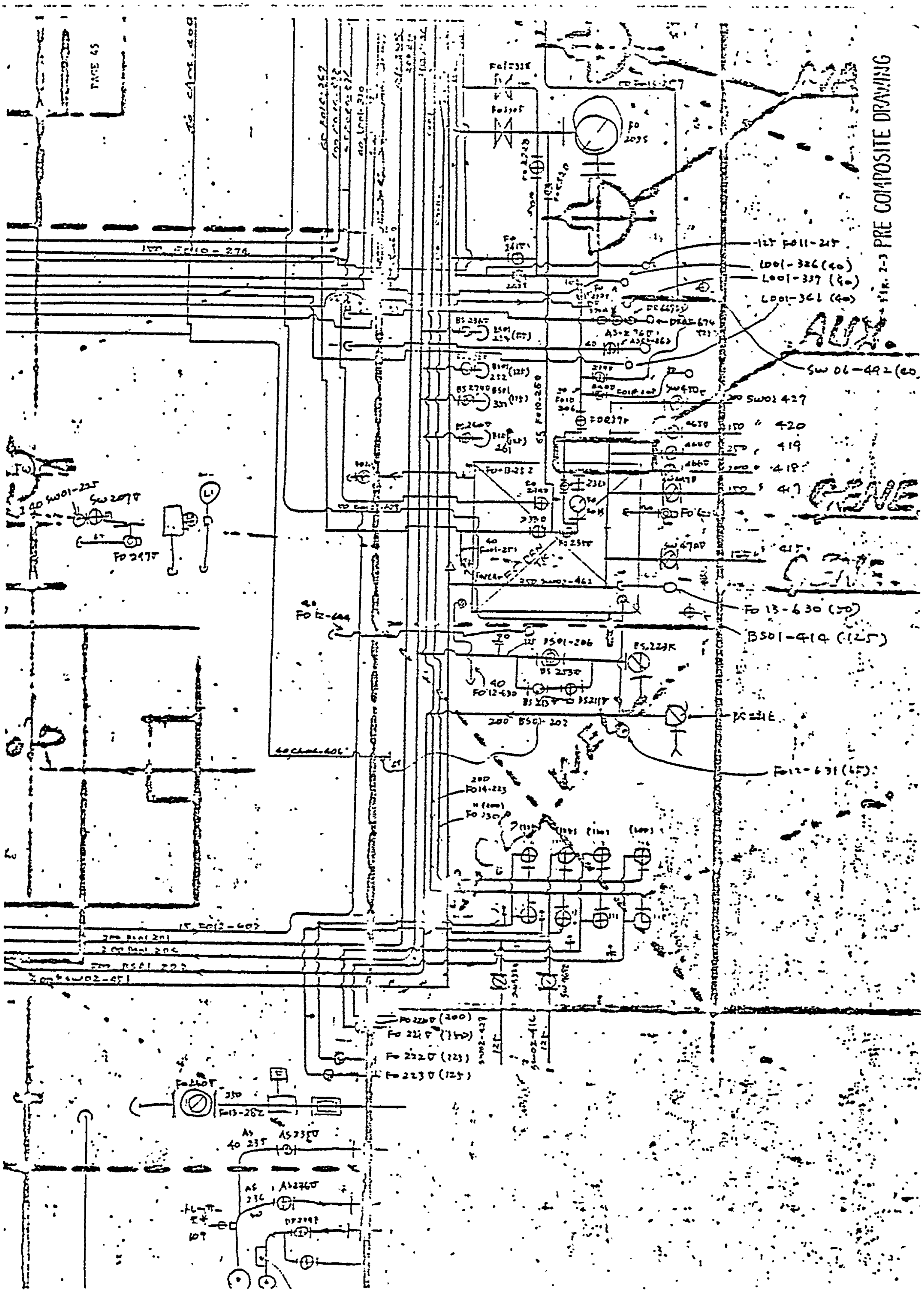


FIG. 2-3 PRE COMPOSITE DRAWING

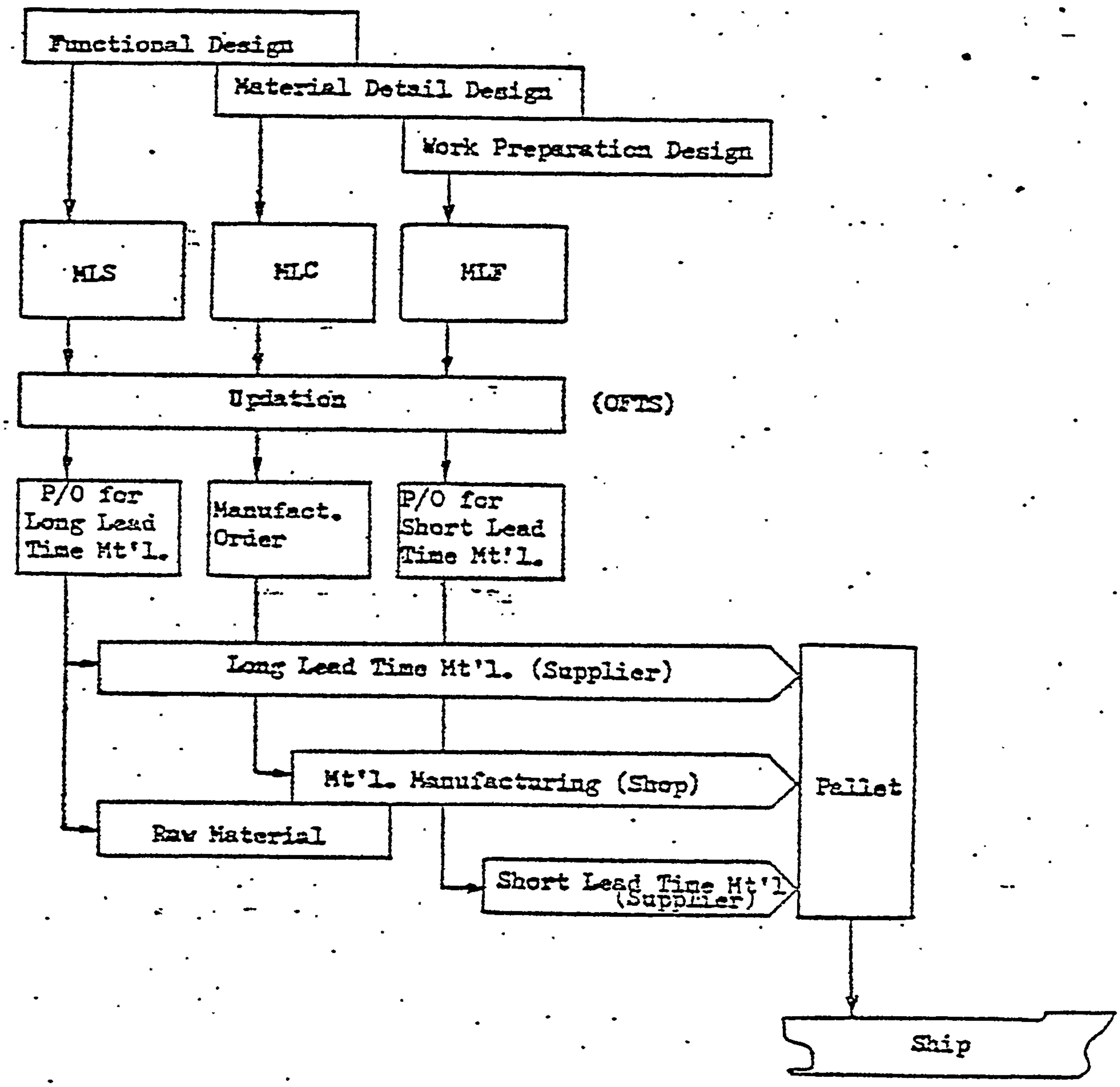
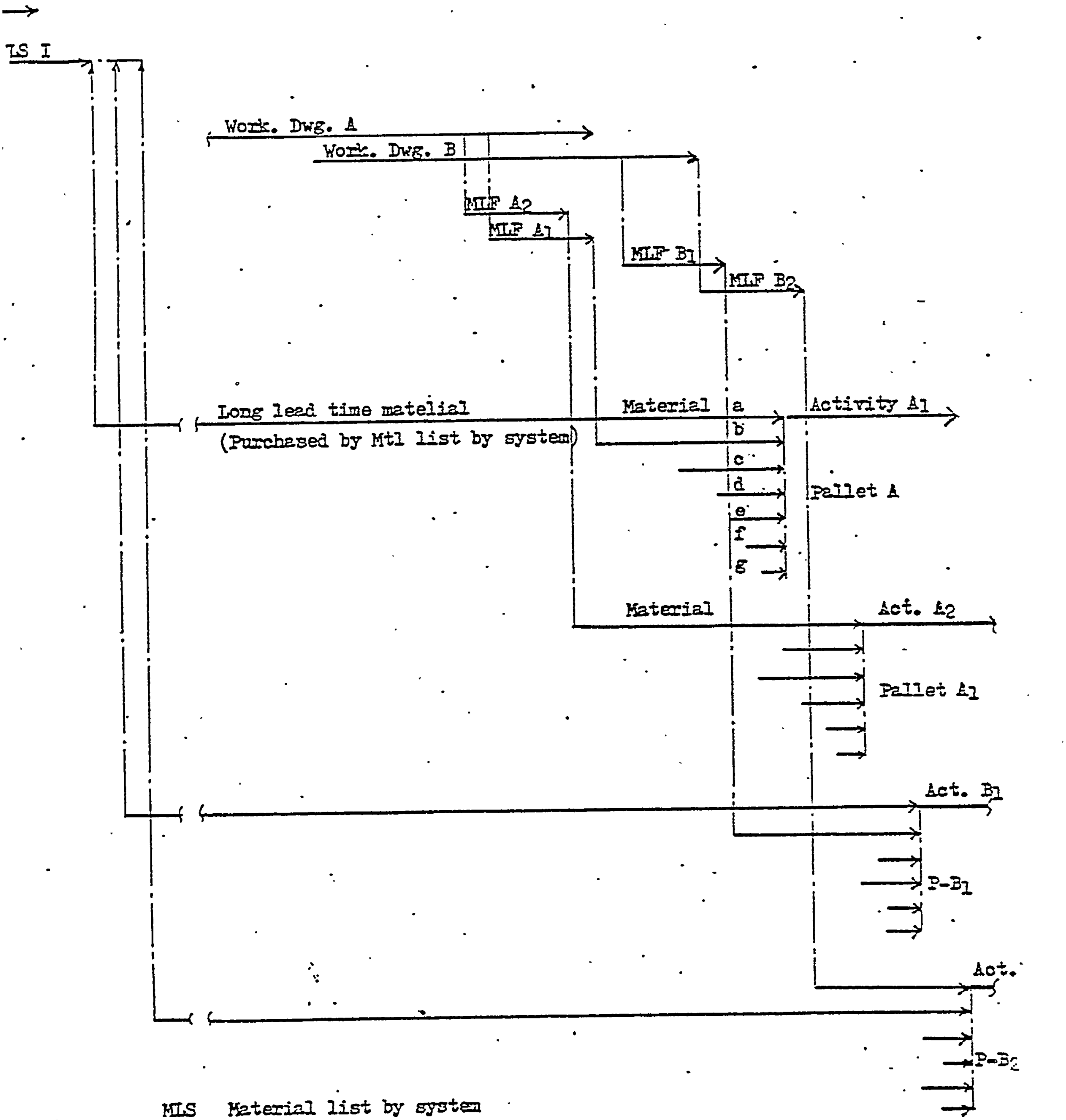

Functional Design
Material Detail Design
Work Preparation Design
MLS
MLC
MLF
Updation
(OFTS)
P/O for Long Lead Time Mt'l.
Manufact. Order
P/O for Short Lead Time Mt'l.
Long Lead Time Mt'l. (Supplier)
Mt'l. Manufacturing (Shop)
Raw Material
Short Lead Time Mt'l (Supplier)
Pallet
Ship

Fig. 2-4



MLS Material list by system

MLF Material list for pallet

MLF-A_1, A_2 are material lists of work.Dwg. A but divided for stage A_1, A_2.

Fig. 2-5

2. Design Phase

2.1 Requirement for Design or Production Planning

It is an organizational option as to whether the conditions discussed shall be required for the Design Department and/or the Production Planning Department. Provided below are the options of the Design Department:

1) Composite Drawing

The method developing the design is as follows:

A:	Schematic Piping Diagram	Functional Design	Scantling Design
	↓	↓	↓
B:	System Arrangement (piping, ducting, wiring, etc.)	Machinery Arrangement	Fabrication Plan (for components)
	↘	↓	↙
C:		Composite Drawings	

Let A, B and C represent the levels of the design developing stage. A level drawing is a segment of the functional design without any specification of position. B level drawing specifies the rough position or dimension for the actual system, machinery or components. C level drawing specifies position, with an interrelationship of all materials and hull construction. This is the composite drawing.

This C level composite drawing is very important for palletizing. The area of the drawing includes the region

of job units and accordingly, all the jobs accompanied with all the materials in that region. If the composite drawing cannot include all the materials in that area (i.e., composite drawing of-piping only), palletizing may be incomplete.

As the method above simply shows, the composite drawing is based on the hull structural. But the revision of the hull structure may be required from the outfitting standpoint, and the hull structure will be revised at the desk, not at the construction site. It goes without saying that this will also increase the efficiency of outfitting.

2) List of Material for Outfitting

The unit of material flow or the unit of *a* job can be brought to view by the *list* of materials for outfitting (referred to as MLS). It is the list of materials contained in the unit of a job referred to in 1) above. *There* are three aims of the MLF:

(1) To present MLF as a process, *a* schedule unit, used for. considering when to start jobs contained in the MLF and when to end them.

(2) To present HLF as a delivery date unit, used for considering the time allowed up io the delivery date of each piece of material contained.

(3) Loading of each material in the pallet according to the MLF.

The MLF is made from the composite drawing and the list of materials for requisition. The time allowed for the MLF to be made depends on the necessary date of the pallet and the lead time of each piece of material in the MLF. Who should make the MLF depends on the organization and circumstances.

Therefore, the requirement for design as to the MLF is only to. figure all the necessary information in the composite drawing. The MLF is related to the list of materials for requisition iii the following (the list of materials for requisition corresponds to design levels A and B):

Requisition: Each material delivery date is estimated from the Milestone Schedule.

MLF : Each pallet delivery date is determined by detail planning for palletizing, namely monthly and weekly schedules.

The above relationship shows, that it is possible to revise each material delivery date when the MLF arid its schedule are made. But the careful planning of palletizing and the information from that planning can minimize such a revision.

2.2 Drawing Issue Schedule

Drawings that are necessary for palletizing *are:*

1) Composite Drawing
2) Working Drawing
3) Material List for Pallet (MLF)

These drawings-must be issued in advance of the date for purchasing, manufacturing and palletizing of materials so that the palletized materials are delivered in time to meet production engineer's requests.

The issue date of MLF (A) is decided by:

1) The delivery date of each pallet *to a* production site (B).

2) *The longest* lead time among *various materials of-short lead time* contained in a pallet (C), *as shown* in Fig. 2-5.

(A) = (B) - (C)

Actually, however, since various materials have various lead times, they are divided into *several* groups of pallets which have similar lead times, rounded to a whole *number, as* a criterion of the scheduling for drawings in order to make the scheduling simple; *for example,* a group of pallets has lead time of *one* month, another has two months, and so on.

This scheduling is performed referring to the lead time of only the material which has short lead times. Material with

long lead times can be ignored for this scheduling because preparation of these materials must have been completed in the early stage by functional drawings arid their material lists (MLS = Material List by System). See Fig. 2-4.

Starting date for making the "Material-List of Pallet" is decided, adding its duration to the issue date of drawings. Also, the starting date of the composite drawing is principally decided, adding its duration to the issue date of the "Material List of Pallet." It should be noted that the "Material List of Pallet" can be started and completed before completion of the composite drawing and "Material List of Pallet” should be carefully controlled because the earlier the issue of the list and the more accurate the list, the more efficient the production preparation.

23 Composite Drawing (Figs. 2-3 & 2-6)

The composite drawing can be divided into two kinds of drawings. One is the composite *drawing* itself and the other is the working drawing. The former is used for studying all the installations for machinery, equipments, piping and all *other* outfitting materials, and for checking interferences between them and with *steel* structures. The later is used for installations in the yard, therefore, it is usually issued segregated by zone, trade and stage. The latter can be developed from the *former* by means of the photographic technique.

After taking a copy of one zone from a composite drawing, the lines which have to be worked out by that activity (trade and stage) are emphasized by the photographic technique. And particular information for workers, such as sizes and clear-antes necessary for installation, installation sequence, loose flange, weight for loading, etc.; are added. The most *important* aspect of the working drawing is that all work included in one work job order can be completed from one working drawing without the help of other drawings.

We also have preliminary composite drawings, but these drawings are only developed in the process of developing the composite drawing for convenience, if necessary. (See Chapter II, 1.2.)

The-composite drawing requires much more information than any other drawings that are to be issued. Therefore, the draftsman for the composite drawing has to be a person who has a comprehensive faculty for understanding not only functional matters but also production matters. Sometimes, he has to go on board to see actual situation of outfitting and to discuss matters in problem, if any, with PPS engineers and foremen.

The composite drawing has to have the following information:

1) Information on hull structure such as location, shapes and sizes of web frames, face plates, stiffeners, brackets, chocks, block joints, seams, butts, lightning holes, drain holes, air holes and all other information which affects the installation of outfitting materials.

2) Location, shapes and sizes of all machinery, equipment, instruments, facilities, electric cablevays, ducts, racks, shelves, etc.

3) All details-have to fulfill functional requirements.

4) All machinery and equipment are arranged to have adequate spaces for operation, overhauling and maintenance.

5) Machinery, equipment, and hull structures do not interfere with each other.

6) Dimensions and sizes indicating locations, shapes, distances, clearances and tolerances necessary for installation are to be indicated.

7) Piece numbers for machinery, equipment and pieces necessary for installation are to be indicated.

8) Installation sequence.of machinery and.equipment are to be indicated.

9) Loose pipe and make-up pipe are to be indicaced. The irF-dications are also used for pipe installation sequence.

20) Particular notices fOr installation, if any, are to be indicated:

2.4 Material List for Pallet (MLF, See Fig. 2-7)

Material List for Pallet must list all *materials* that are necessary to complete jobs in one work order, for example, pipe pieces, flanges, bolts, nuts, gaskets, nameplates, etc as well as major materials. Jobs in one work order mean. jobs in one activity or jobs in one zone, but diVided by trade and stages, if any.

1) Major Information to be included in Material List for Pallet

Material List for Pallet must include information necessary for installations, such.as:

(1) Pallet number

(2) Name of material

(3) Identification for installation (piece number)

(4) Specification

(5) Quantity

(6) Weight

(7) Sketches, if necessary

(8) Information for *assembly*

(9) Working drawing number corresponding to this list

(10) Information for manhour calculation for jobs included in this *list*

(Item No. corresponds to the COlumn No. of MLF in the circle)

Details of above items are as follows:

(1) Pallet Number is used for identification in order to know

When we have to start this palletizing

When we have to deliver this pallet

Where we have to deliver this pallet

Where we have jobs of this pallet

When we have *to do* jobs of this pallet

To whom we have to deliver this pallet

(2) Name of Material *is* indicated for each item of material listed so that anyone can understand it. *Some* kind of code can be used for identification in a computer system in addition *to the* above.

(3) Identification for Installation (piece number) is used for identification of each listed piece (see Note) *which* has to be indicated on the working drawing for convenience of installation.

Note: Piece is not material., therefore, piece number is not material code, e.g., one piece of pipe is composed of two flanges and one pipe.

(4) Specification is diameter of pipe and valve, plate thickness, classification of material, etc.; dia-

meter of pipe and valve is especially important but it may be indicated in Name of Material Column instead this column .

(5) Quantity - No explanation is necessary.

(5': Unit of quantity)

(6) Weight is used for planning of jobs, such as lifting weight, total weight of assemblies, or index for checking job progression such as total loading weight per month.

(7) Sketches is convenient for identifying materials such as pipe pieces , especially for"unskilled workers.

(8) Information for Assemblv is used for indicating sequence of jobs, units to be pre-assembled, or notation for special installation.

(9) Working Drawing Number is the drawing to be referred to accomplish jobs relating to this pallet.

(10) Information for Manhour Calculation (Control Weight) is used for manhour calculation for jobs included in this pallet. Manhour Calculation is used for control.

Material List for Pallet is also used for palletizing materials in the warehouse, and for checking received materials by foreman in the yard. Sometimes, comments on

installation *or* material itself is fed back to the design engineer. Therefore, Material List for Pallet has to be a list that people in design, *material* procurement plan-ning, scheduling, and the foreman and worker can chase material easily by referring to this list.

2) Other Information included in MLF of IHI

(See Fig. 2-7; ItemNo.. corresponds to the column of MLF in the circle)

(5') Unit of Quantity, 1: piece, set, sheet, etc.

2: g (gram)

3: kg (kilogram)

4: m

5: m^2

6: m^3

7: 1/1000 m^3

8: ℓ

(10') Identificatim of Weight for manhour calculation,

Blank: Weight of material not proportional to outfitting manhour

(ex. Main engine, diesel generator, etc.)

1 Weight of material proportional. to outfitting manhour. (= Control Weight)

(11) Ship Number

(12) Required Date for Pallet

13) Next Stage (MLF-NO.)

(14) Responsible Outfitting Shop (Code No. of each shop)

(15) ResponsibIe Design Section (Code No. of each section)

(16) Page Number means the page of each MLF sheet in the all MLF sheets printed out in a day. It is serial number and.used for identification between different shops or design sections.

(17) Length of Electric Cable if any

(18) Weight of Pallet; The upper figure shows sub-total weight in the sheet and the lower figure accumulated weight of the pallet. Weight of temporarily located material which *is to be* outfitted by other MLF after loading onboard is not included.

(1 9) Erection (Loading) Weight includes the weight of temporarily located material.

(20) Page of MLF within a pallet

(21) Fabrication Sign indicates information of fabrication process to be applied to the pipe piece before final.,installatlon.such as for make-up pipes *or* a pipe pieces which need to be finish painting in the pipe shop. after decision of the dimension.

(22) Temporary Location sign

1 :To be finally installed at the next stage..

2: To be finally installed at this stage, i.e., the material is temporarily located at the preceeding stage.

(23) Painting Schedule code of which is given by IHI standard SOT-A280201.

(24) MLF No. for Temporarily Located Material

1: MLF No. of the next stage.

2: MLF No. of the preceding stage.

(25) Reference Drawing No. for example, drawing number of the fabrication drawing or purchase order specification for the material.

(26) Material Resources identifies resource of the material such as allocated material purchased for a specific ship or stock material etc.

(27) Material Code is IHI standard code given for the material and used commonly for various ships.

(28) Classification of the Material is classification standard for the material such as IS (IHI Standard), JIS (Japanese Industrial Standard), ABS etc. This classification may be given by (4) Specification as practically.

(29) Remarks; Any special remarks other than (1) - (28).

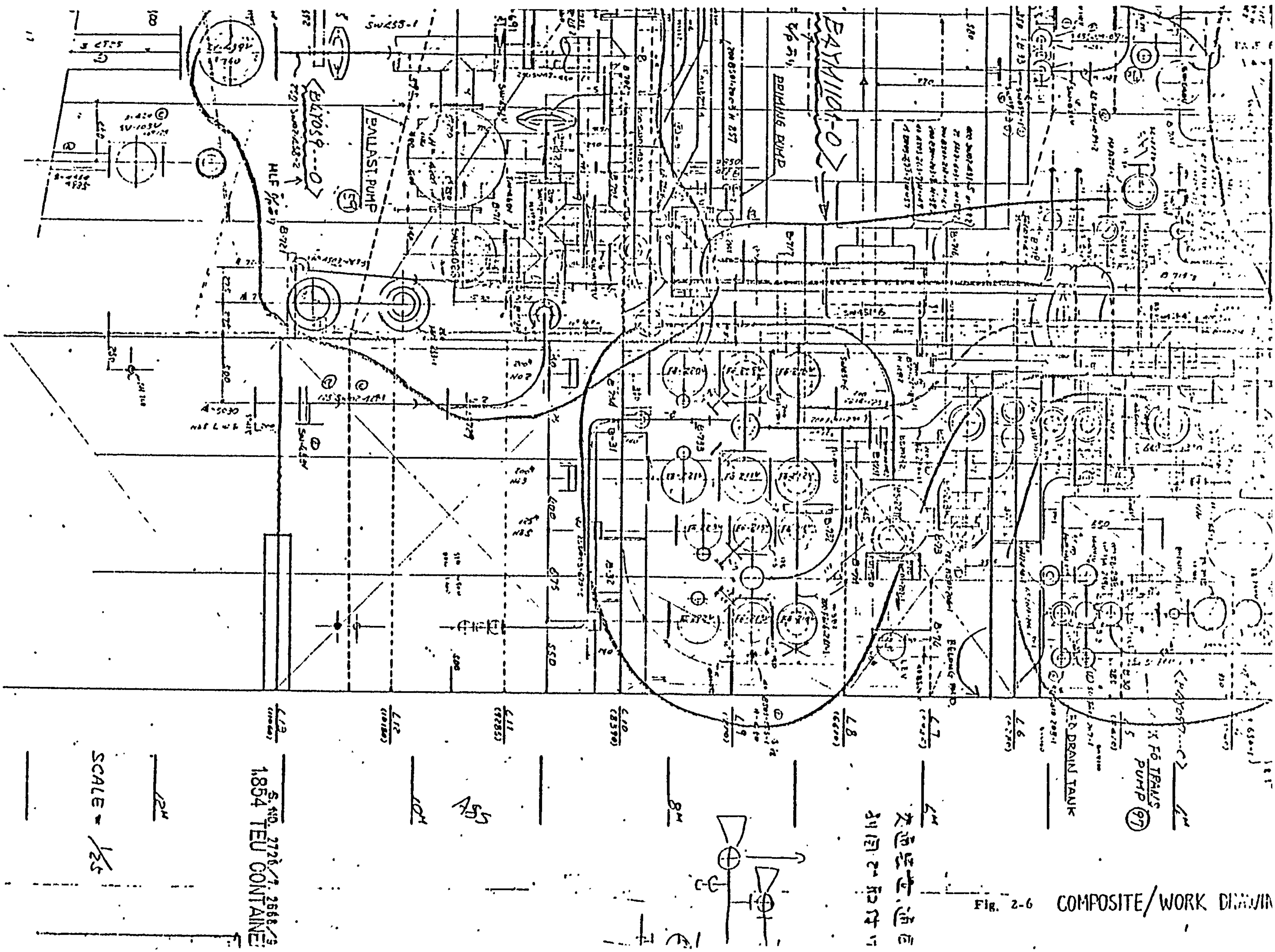


Fig. 2-6 COMPOSITE/WORK DRAWIN

M L F

作成年月日 79. 06. 06

② 品名 材質・型式・規格・寸法		部品符号 ③			① 引当指示項目 (コメント)	数量 ⑤			重量 ⑥	仕装	引当図番 / ステージ移行		購装品コード ㉑			備考 ㉔
		AS203-5	U		FF50 3.9M 40A 15	1	1	1	18.3	E05	27	1				+
		AS203-6	U		FF30 2.0M 40A 15	1	1	1	109	E64	27	1				+
		BS202-3	U		FF70 3.9M 200B	1	1	1	1747	R44	44	1				+
		BS203-9	U		FF20 2.4M 200B	1	1	1	1170	R44	44	1				+
		BS210-2	U		FF70 3.3M 200B	1	1	1	1543	R44	44	1				+
		F0253-1	U		FF30 3.3M 250B	1	1	1	218[illegible]	C42	34	1				+
		SW404-4	U		FF20 1.2M 300A	1	1	1	50[illegible]	S92	61	1				+
		SW404-5	U		FF20 .6M 300A	1	1	1	532	S92	61	1				+
		SW404-6	U		FF20 .4M 300A	1	1	1	435	S92	61	1				+
		SW429-2	U		FF20 1.0M 125A	1	1	1	22[illegible]	S92	61	1				+
		SW429-3	U		FF20 .6M 125A	1	1	1	16[illegible]	S92	61	1				+
		SW429-4	U		FF20 .7M 125A	1	1	1	17[illegible]	S92	61	1				+
		SW429-5	U		FF20 .4M 125A	1	1	1	136	S92	61	1				+
		SW429-6	U		FF20 .5M 125A	1	1	1	15[illegible]	S92	61	1				+
		SW451-7	U		FF21 2.6M 400A	1	1	1	266[illegible]	S92	61	1				+

番船	M.L.F - No.	作業開始日	次のステージ
⑪	①	⑫	⑬

志隊員	パレット重量	管理重量	搭載重量	頁
⑰	⑱ 1257	⑲ 1257	⑲ 1257	⑳

Fig. 2-7 (1/6)

M L F

SOT-A280201参照

作成年月日 79. 06. 0[illegible]

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量		引当図番 / ステージ移行		購入品コード			備考
		SW452-1	U		FF11 .7M 300A	1.0	1	1	107.[illegible]	S92	61	1				+
		SW458-1	U		FF21 .9M 250A	1.0	1	1	66.3	S92	61	1				+
		SW458-2	U		FF20 .9M 250A	1.0	1	1	63.0	S92	61	1				+
		SW460-1	U		FF10 .7M 250A	1.0	1	1	48.4	S92	61	1				+
BC GLOBE VALVE BC FGU 16025		SW-413V			? 不pn.	1.0	1	1	5.7	NOP			5403221005	1	0	+
BC SCREW/BITE GLOBE V. BC M-SCR, FGT 20010SBC		SW-412V				1.0	1	1	1.0	NOP			4403245C02	1	0	+
SC/BC SHELL V.LINING SC/BC SHELL V.LINING		SV-439V			10K-250	1.0	1	1	259.0	C42	N404100UA		1404190000			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)		SW-456V			FC25 SCS13 5K # 250	1.0	1	1	300.0	C42	N4044000		14C445CCCU			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)		SW-458V			FC25 SCS13 5K # 300	1.0	1	1	400.0	C42	N4044000		1404450000			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)		SW-460V			FC25 SCS13 5K # 300	1.0	1	1	400.0	C42	N4044000		1404450000			+
BLIND FLANGE (W/HANDLE) SS41 GALV.FB 5K 300SS1						1.0	1	1	27.0	R44			44C6S1C187	1	A	+
WATER FILTER WATER FILTER		SW-402S			5K-250C BALLAST PP	1.0	1	1	246.0	C42	N4082400		140825C5C0			+
GASKET ASBESTOS PA 5K 12500						50	1	1	0.0				5408401113	1	0	+
GASKET ASBESTOS PA 5K 20000						30	1	1	0.[illegible]				54C84C1115	1	0	+
GASKET ASBESTOS PA 5K 25000						70	1	1	1.4				5408401118	1	0	+

名 称	MLF－No	作業開始日	次のステージ		重量	パレット重量	管理重量	搭載重量	頁
2726	84Y029---1	79 01 22	T400S H ステージ	7001 2 A 7 42 PAO. 11		957 2213	957 2213	957 2213	

(2232)

Fig. 2-7 (2/6)

M L F

Fig. 2-7 (3/6)

作成年月日: 79. 06. 08

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量	倍数	引当図番 / ステージ移行	梱装品コード		備考
GASKET / ASBESTOS PA 5K 30000I			60	1	1	10			540640116710		+
GASKET / ASBESTOS PA 5K 35000I			10	1	1	04			540640116810		+
GASKET / ASBESTOS PA 5K 40000I			10	1	1	05			540640116910		+
GASKET / ASBESTOS PA 10K 400J			20	1	1	00			440641216710		+
GASKET,RUBBER SHEET / GASKET,RUBBER SHEET	GH/00IPP	5K-500 FOR LINING 7511	10	1	1	100	00P	N40849600A	1408492000		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 16S 505G			520	1	1	52	600		540521751310		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 20S 605G			240	1	1	72	600		540521761510		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 20S 655G			600	1	1	180	600		540521761610		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 20S 705G			540	1	1	162	600		540521761710		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 22S 705G			60	1	1	24	600		540521771710		+
HEXAGON HEAD BOLT/NUT / SS GALV.BN 22S 755G			220	1	1	88	600		54052177[illegible]10		+
BALLAST PUMP / BALLAST PUMP	MA-059AA	VLC 500M3/H * 25M	10	1		5900		N44510600A	1445106000		+
MOTOR (BALLAST PUMP) / MOTOR (BALLAST PUMP)	P/BTP-M	55KW 1800RPM TE V B	10	1		.5400		N4451070	1445107000		+
PIPE BAND SUPPORT / PIPE BAND SUPPORT		N=24	10	1	1	654		F4634002	2463400000		+
VERTICAL LADDER / VERTICAL LADDER	NG-102V	VFS-5 L/700 表面処理加工	10	1	1	97	633	F4030214	4463020000		+

立	初	MLF - No.	作業開始日	次のステージ

実際日	バレット番号	管理番号	搭載番号	頁
	1266	156	1286	

M L F

SOT-A280201参照

作成年月日: 79. 06. 06

品名 / 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量	重量		引当図番 / ステージ移行	積装品コード	備考
FLOOR & GRATING FLOOR & GRATING	-0090		交通装置取付図	1011	920		F4031810	24031CCC00	+
FLOOR & GRATING FLOOR & GRATING	6-1020			1011	213		F4031810	24031CCCC0	+
AUX MACHINE SEAT AUX MACHINE SEAT	-0 [illegible]	07	PUMP	1011	3280	133	F4058055	24058ECCCC	+

番船	MLF－No	作業開始日	次のステージ
2726	64Y059	79 01 2	[illegible]

2001 2 0 7 42 PNL 13

電線具	パレット重量	管理重量	搭載重量	頁
	442	442	442	
	3542	2812	3942	4

(2232)

Fig. 2-7 (4/6)

M L F

作成年月日: 79.07.16

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量		引当図番 / ステージ移行			艤装品コード			備考
MAIN DIESEL ENGINE											N4111010	A					
MAIN DIESEL ENGINE		MA-001AA			IHI SULZER 12RND90M	10	1		9990000					1411101000			+
MAIN DIESEL ENGINE											N4111010	A					
MAIN DIESEL ENGINE		MA-001AB			IHI SULZER 12RND90M	10	1		3130000					1411101000			+

SOT-A280201参照

1. 管理重量

1. 仮区品（次のステージで本付されるもの）
2. 仮区品（前のステージで仮区されたもの）

仮区サイン 1.次のステージのMLF No.
仮区サイン 2.前ステージの MLF No.

M/E

図	番	MLF − No.	作業開始日	次のステージ

重量	パレット重量	管理重量	搭載重量	頁

Fig. 2-7 (5/6)

Fig. 2-7 (6/6)

M L F

SOT-A280201参照

ABC…又は 1.2.3…

1 仮置品（次のステージで本付されるもの）

2 仮置品（前のステージで仮置されたもの）

仮置サイン 1.次のステージのMLF No

仮置サイン 2.前ステージの MLF No

1. 引当購入品 2. 支給購入品 3. 加工支給品 4. 引当貯蔵品 5. 一般貯蔵品

作成年月日
79.07.1

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量		重量	塗装	引当図番 / ステージ移行	艤装品コード	備考
MAIN DIESEL GENERATOR / MAIN DG	P/DG-6	1600KW 600RPM 450V 3P	20	1	248000		N5111110	1511111000	+
MAIN DIESEL GEN ENGINE / MAIN DG ENG	MA-012AA	1600KW GEN DIESEL ENGINE	10	1	312000		N5111030C	1511112000	+
MAIN DIESEL GEN ENGINE / MAIN.DG ENG	MA-012AU	1600KW GEN DIESEL ENGINE	10	1	312000		N5111030C	1511112000	+

番 給	MLF − No	作業開始日	次のステージ
2726	[421--AD-1	79 02 2?	

補材，D/G

ZMK01 6 6 42 PNO. 6

重量	パレット重量	管理重量	搭載重量	頁
	07200		07200	
	07200		07200	1

(7?12)

3. Material Control

3.1 Scheduling for Material Procurement

The most important point for palletization is to prepare a pallet without missing material in a timely manner. To satisfy the above requirement, materials have to be purcha stocked, expedited, received and issued by a material proc ment schedule which is prepared on the basis of the requir date of each pallet. An example of material procurement scheduling is indicated in Fig. 2-8. Explanation of words used in Fig. 2-8 is as follows:

Material Delivery Date is the date that the pallet is reque -ed to be delivered to yard; this date is decided by an out ing control engineer daily or weekly, reflecting current situation of jobs.

Required Date for Pallet is the scheduled date by which a pallet should be ready to be delivered from the warehouse with a few days advance of the Material Delivery Date. This advance is necessary for preparation of issuing the pallet.

Material Issue Request is request for delivery of pallet, b pallet number. Issue of Materials is ordered by Material Issue Order. (Figs. 2-9, 2-10)

List of Missing Material (Fig. 2-11) lists missing material in a pallet which is going to be delivered by Material Issue Request. The outfitting control engineer, foreman and his workers can know that they will have missing material in their next job by this list.

List of Delayed Material (Fig. 2-12) lists materials which are delayed from contracted date. The material expeditor has to expedite these listed materials in order to obtain them by the material distribution date. When he is unable to obtain the delayed material in time, he has to list that material in the List of Missing Materials.

Vendor Delivery Date is the delivery date of an item of material on a contract between vendor and shipyard.

Starting Date of Palletizing is the same date as the vendor Delivery Date, taking into account of few days' duration for palletizing.

When the Material Delivery Date arrives, the outfitting control engineer prepares a Material Issue Request for particular pallets for which he wishes to start corresponding jobs. By request, the warehouseman delivers the requested pallets; the status of outfitting jobs changes daily, although palletization occurs on the basis of the outfitting schedule.

In IHI, time spans A, B, C, and D in Fig. 2-8, are 60, 7, 15 and 10 days, respectively, but they vary on a case-by-case basis.

Many kinds of materials which have different lead times, from more than one year to less than one week. Materials which have long lead times must be purchased early in the design phase; materials such as machinery, motors, starters, anchors, bollards, special valves, large valves, castings, furniture, etc., must be purchased by material list by system (MLS), which is prepared when a functional drawing is completed.

Fortunately, these major materials, with their quantities can be listed in the early stage and the date for purchasing these materials can be easily determined on the basis of the required date of the pallet. Because the locations of these materials are clear on the functional drawing, then we can easily determine the need date from the master schedule.

Information for Expediting lists the materials that are scheduled for delivery within a few months. The expeditor can pay attention to particular materials in order to begin expediting, if necessary, by this list.

Date for Placing Purchase Order is a date on which the purchaser must place an order for material for a manufacturer. This date can be determined by taking account lead time and Vendor Delivery Date.

Thus, we can determine the date for placing an order for each item of material and put it together to form the material purchasing schedule. But actually, we have to place an order taking into consideration not only the above schedule but also the market condition, purchase *lot,* etc.

3.2 Expediting and Palletizing

After placing an order, we have to prepare Information for Expediting in order to obtain material of a pallet in *time.* When the Vendor Delivery Date passes, we have probably received almost all of the material for one pallet, because the purchasing schedule is determined on the basis of Required Date of Pallet. Even so, we may experience a delay in material receipt. If material is delayed; it must be listed in the List of Delayed Material within a few days after Vendor Delivery Date in order to expedite that material. Then, we have to start palletizing materials.

If we find that *getting* material in time is impossible, th materials must be. listed in the List of Missing Material. The outfitting control engineer or foreman must decide whether he should start a job now or wait in order to minimize loss which might be caused by missing materials until the missing material is supplied with Supply List of Missing Material (Fig... 2-13).

Materiels which have short lead time are troublesome. We can not definitely list these minor material especially with their quantities, in an early stage when only functional drawings are available. Besides, we have.to hold listing them with their definite quantities, because we cannot determine quantities and locations of these minor materials such as drain valves, small pipe, flanges, elbows, reducers, plugs, pipe supports, electric cable trays, *wire* nets, rings, eyes, etc., by functional drawings only. We have to hold purchasing until after working drawings are completed. Fortunately, they have short lead times. Therefore, if we can schedule the working drawing and/or material list of pallet to meet the material purchasing schedule, we can complete these drawings in a comparatively late period without impacting the pallet schedule. Fig. 2-4 shows this aspect.

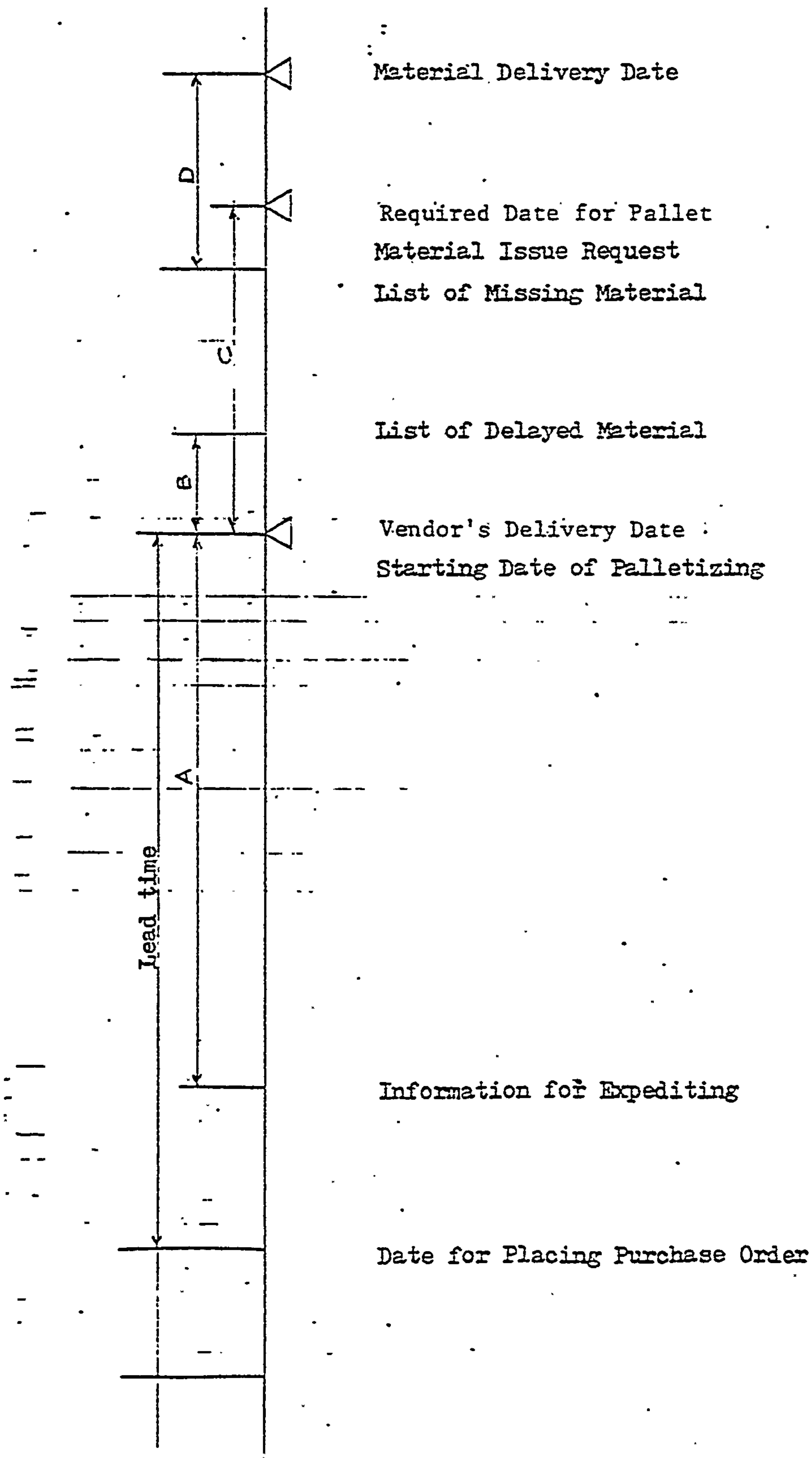

Material Delivery Date
D
Required Date for Pallet
Material Issue Request
List of Missing Material
C
List of Delayed Material
B
Vendor's Delivery Date
Starting Date of Palletizing
A
Lead time
Information for Expediting
Date for Placing Purchase Order

Fig. 2-8

本船 2600 | ML No. I4630J1P-0

M L 出庫指示表 (1)

(79年6月15日) PAGE

No.	管理区分	補充品コード	訂改	品名・型式・規格・寸法 / 引当指示項目	課	番船	課	注文番号	回	配給先	単位	数量	ML-No.	改正	分割	部品番号 / 図面番号	改正	設計担当	保管場所	重量	棚番	備考
57	53	40921/017	L0	DEAERATOR HEATER HOT/HOT SS VALV.AN 2S3 /2050 00921/2010	004	2600				34	1	30	I4630J1P-C	A		MM		2	51	9		
57	53	00921771	L0	DEAERATOR HEAT HOT/HOT SS VALV.0B 223 7200 00921771	004	2600				34	1	120	I4630J1P-C	A		MM		2	51	50		
82	11	40052100A		EYE PLATE / EYE PLATE	004	2600	25	14180	0	34	1	2	I4630J1P-C	A		NL-G00P / F4605211		22	51	31		
87	11	40972000A		LIFTING BEAM / LIFTING BEAM FOR DIESEL GENERATOR	004	2600	25	14403	0	34	1	1	I4630J1P-C	A		NL-24108 / F4897241		22	C7	11		
81	21	40210000A		VENTILATION TRUNK / VENTILATION TRUNK	004	2600	25	14410	0	34	1		I4630J1P-0	A		VV-2222 / F4821122	A	22	C7	272		
81	21	40210000A		VENTILATION TRUNK / VENTILATION TRUNK	004	2600	25	14410	0	34	1	1	I4630J1P-C	A		VV-2232 / F4821122	A	22	C7	41		
81	21	40210000A		VENTILATION TRUNK / VENTILATION TRUNK	004	2600	25	14410	0	34	1	1	I4630J1P-C	A		VV-2242 / F4821122	A	22	C7	480		
81	21	40210000A		DOOR & GRATING / DOOR & GRATING		2600	25	14441	1	34	1	1	I4630J1P-C	A		VG-3212 / F4811272	B	22	C7			
81	21	40321000A		INCLINED LADDER / INCLINED LADDER A-3 H/2500 B/600 A/55	004	2600	25	14443	0	34	1	1	I4630J1P-0	A		VG-2216 / F483						
81	21	40321000A		INCLINED LADDER / INCLINED LADDER A-3 H/2500 B/600 A/55	004	2600	25	14443	0	34	1	1	I4630J1P-C			VG-						

Parts No.

Design Section

Unit

Stowing Area

Description

Destination

Weight

Pallet No.

Alteration

P.O. number

Material Code

Purchasing Section

Quantity

Shelf No.

Material Control Classification

Ship Number

番船	ML No	変更No
2080	[illegible]	

ML出庫指示表 ( )

(79年 6月 15日) [illegible] [illegible] PAGE [illegible]

作業番号	材質区分	精製品コード	設改	品名略号 / 材質・型式・規格・寸法 / 引当指示番号	塗装	番船	課	注文番号	回	配給先	単位	数量	ML−No	改正	分割	部品符号 図面番号	改訂	請求担当	保管場所	適用数量	重量	図番	備考
[illegible]	22	[illegible]	[illegible]	GASKET / ASBESTOS PA 10K [illegible] / [illegible]		2080				45	1	9	14G1D315-0	A		MM		L	51				
[illegible]	22	[illegible]	[illegible]	GASKET / ASBESTOS PA 10K [illegible] / [illegible]		2080				45	1	6	14G1D315-0	A		MM		L	51				
[illegible]	[illegible]	[illegible]	[illegible]	GASKET / ASBESTOS PA 10K [illegible] / [illegible]		2080				45	1	1	14G1D315-0	A		MM		L	51				
[illegible]	22	[illegible]	[illegible]	GASKET / ASBESTOS PA 10K [illegible] / [illegible]		2080				45	1	1	14G1D315-0	A		MM		L	51				
[illegible]	22	[illegible]	[illegible]	GASKET / ASBESTOS PA 10K [illegible] / [illegible]		2080				45	1	[illegible]	14G1D315-0	A		MM		L	51				
[illegible]	21	[illegible]		PIPE BAND SUPPORT / PIPE BAND SUPPORT / [illegible]		2080	25	14405	1	45	1	1	14G1D315-0	A		MM E4634111	A	22	51		400		
[illegible]	22	[illegible]	[illegible]	HEXAGON HEAD BOLT/NUT / SS GALVAN [illegible] / [illegible]	[illegible]	2080				45	1	45	14G1D315-0	A		MM		L	51		5		
[illegible]	22	[illegible]	[illegible]	HEXAGON HEAD BOLT/NUT / SS GALVAN [illegible] / [illegible]	[illegible]	2080				45	1	20	14G1D315-0	A		MM		L	51				
[illegible]	22	[illegible]	[illegible]	HEXAGON HEAD BOLT/NUT / SS GALVAN [illegible] / [illegible]	[illegible]	2080				45	1	90	14G1D315-0	A		MM							
[illegible]	22	[illegible]	[illegible]	HEXAGON HEAD BOLT/NUT / SS GALVAN [illegible] / [illegible]	[illegible]	2080				45	1	12	14G1D315-0										
[illegible]	22	[illegible]	[illegible]	HEXAGON HEAD BOLT/NUT / SS GALVAN [illegible] / [illegible]	[illegible]	2080				45	1												
				EYE PLATE / EYE PLATE	[illegible]	[illegible]																	

Format is same as Fig. 2-9 (1/2)

MATERIAL ISSUE ORDER (I)

番船	ML-No	発注先

ML出庫指示表(2)

(79年06月15日) 倉置 C1 配給日 790629 PAGE 19

行番号	口管区分	加装品コード	規改	品名略号 / 材質・型式・規格・寸法 / 引当指示項目	塗装	番船	課	注文番号	回	配給先	単位	数量	ML-No	改正	分割	部品符号 / 図面番号	改正	発注担当	保管場所		首付数量		重量 kg	棚番	備
	11	4L052LUUA		EYE PLATE / EYE PLATE	UU5	2080	25	14480	0	35	1	2	14G3D31P-C	A		NL-C6CP / F48C5211		22	51		0		31		
	11	4U0521UUA		EYE PLATE / EYE PLATE	UU5	2080	25	14480	0	35	1	2	14G4D31S-C	A		NL-06OP / F48C5211		22	51		0		31		

FIG. 2-

Format is same as Fig. 2-9 (1/2)

MATERIAL ISSUE ORDER (II)

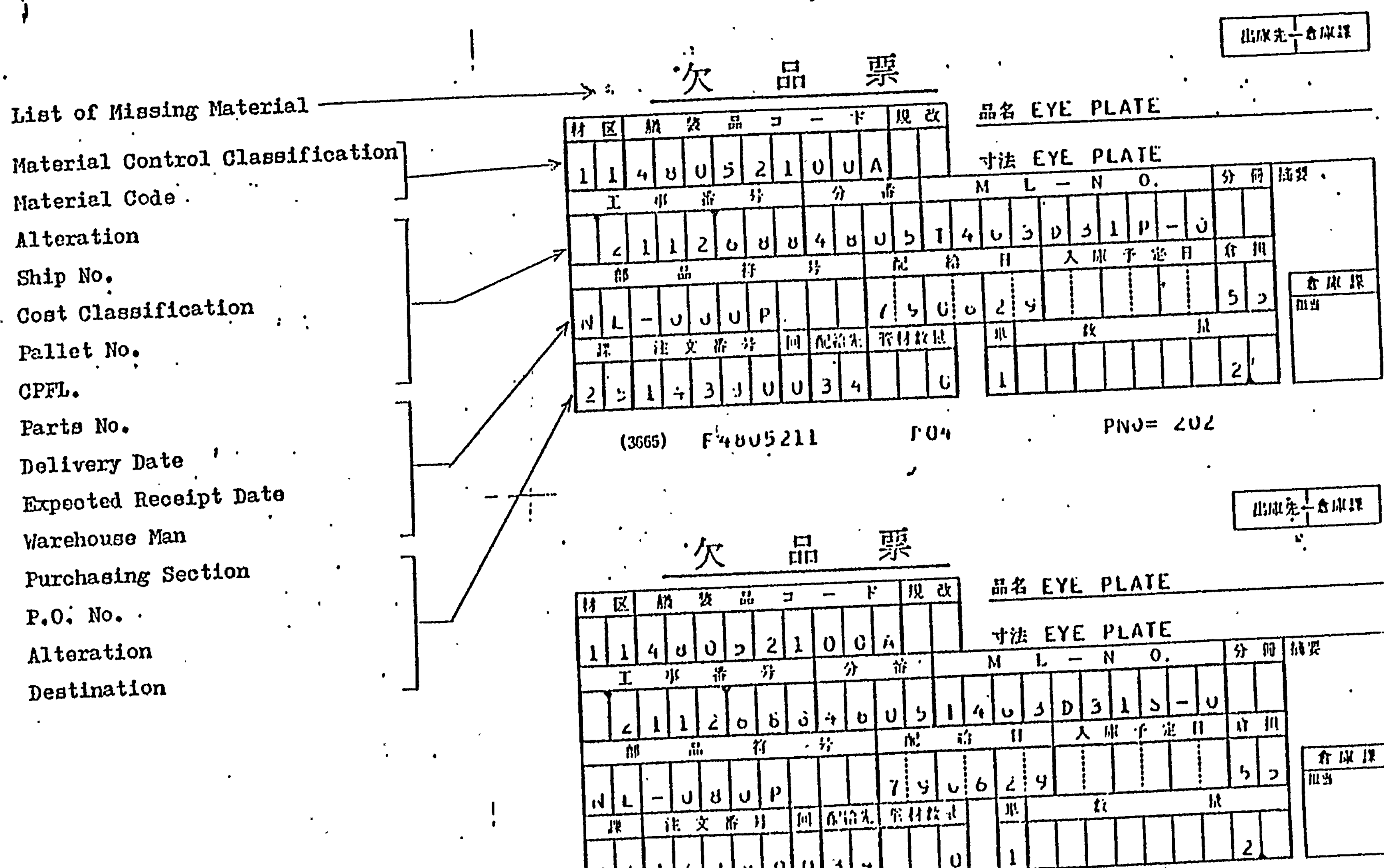


Fig. 2-11 List of Missing Material

帳票番号 (02) ** KK **

未入庫調査表

(79年06月18日) P. 0002

発注先	課	注文番号	回	材管区分	材料品コード / 図面番号	改正	品名略号 / 材質・型式・規格・寸法	工事番号	分番	用途	材入請求日 / 注文年月日	材料最終納期 / 決定納期	納入場所	単位	数量	未納数量
3500	25	651750		41	000650110 / 500006500	F	DECK STAND(WEATHER DECK) / DK STAND W/CANO. 224-255				790 / 790605	000000 / 790612	51	1	-6	-6
3500	25	652310		41	00065111C / 500006510	2	DECK STAND(NON-WEATHER) / DK STAND TYPE-1 224-255				790525 / 790525	000000 / 790610	51	1	6	6
3767	25	751150		21	27320000A		P.ROOM LADDER UNIT / P.ROOM LADDER UNIT	2112726	2732		790531 / 790531	000000 / 790600	2	1	1	1
3767	25	751160		21	27320000A		P.ROOM LADDER UNIT / P.ROOM LADDER UNIT	2112727	2732		790531 / 790531	000000 / 790600	2	1	1	1
4156	25	747330		11	26760100A		GASKET FOR W.D H.COVER / GASKET FOR W.D H.COVER	2112642	2676		790601 / 790615	000000 / 790612	2	1	20	20
6357	25	143800		11	480521 0CA / F4805211		EYE PLATE / EYE PLATE	2112688	4805		790119 / 790501	790622 / 790607	51	1	6	6

課	注文番号	回	入庫予定日				
25	651750			52			
25	652310			80			
25	751150			02			
25	751160			02			
25	747330			02			
25	143800			55			

Q'ty

Warehouse Q'ty

Unit

Warehouse to be Delivered

User's Request Date

Final Delivery Date

Requisitioned Date

Description

Material Control

Material Control Classification

P.O. No.

Fig. 2-12 List of Delayed Material

部　品　票

材区	艤装品コード	版改
1 2	.2 0 8 3 1 0 9 0 7	.

品名　AIR PIPE HEAD
A.P-HEAD 5K-125 (H=450).
寸法　AIR PIPE HEAD

工事番号	分番	M.L-NO.	分冊	摘要
4 1 1 2 7 4 7	2 0 0 2	1 2 4 0 4 P P A - 0		

部品符号	配給日	入庫予定日	仕組
	7 9 0 6 2 5		4 2

課	注文番号	回	配給先	管材数量	単	数量	倉庫課 担当
2 2	4 5 7 3 0 0		3 4	0	1	1	

(3666)F2083011　　V03　　PNO= 578

Format is same as Fig. 2-11

Fig. 2-13 Supply List of Missing Material

4. Outfitting Production

4.1 Functions of Organization

For the operation of palletized outfitting, the zone-oriented organization is-superior to the craftsmanship oriented or.ganiza tion. An example of the zone-oriented organization is shown in Fig.2-14.

As indicated in Fig. 2-15, the functions of each sub-divided organization are as follows:

- Engine room section performs all jobs in engine room except electrical jobs.
- Accommodation section performs all jobs in accommodatio space except electrical jobs.
- Deck and hold section performs-all jobs in spaces other than engine room and accommodation space except electrical jobs.
- Electrical section performs all electrical jobs in entire ship/area.
- Each section has sub-sections, such as unit assembly, on-block outfitting and onboard outfitting.

(Alternative 1) Unit assembly and on-block outfitting be merged into one in each section if estimated total workload of these sub-sections is not great.

(Alternative 2) If estimated total workload of unit assembly and on-block outfitting-in each section is not sufficient to continue these jobs with a reasonable quantity every day, part of the sub-section may be omitted.

(Alternative 3) If estimated total workload of unit assembly and on-block outfitting of all sections is sufficient to continue these jobs with a reasonable quantity every day, a common and merged unit assembly and on-block outfitting section may be advisable.

- Material preparation section performs material gathering marshalling, palletizing and delivery. Details are described in CHAPTER II, 4.3, “Material Marshalling and Palletizing.”

- Material preparation section consists of palletizing group and transportation group.

  Palletizing group performs material gathering from warehouse or manufacturing shops, marshalling and pelletizing materials.

  Transportation group performs delivery of pallets to destinations requested by production control engineer.

- Manufacturing shop, manufacturing pipes, ducts, doors, hatches, machinery, equipment, etc., has to be operated independently. from the others, because manufacturing shop operation and procedure are quite different.

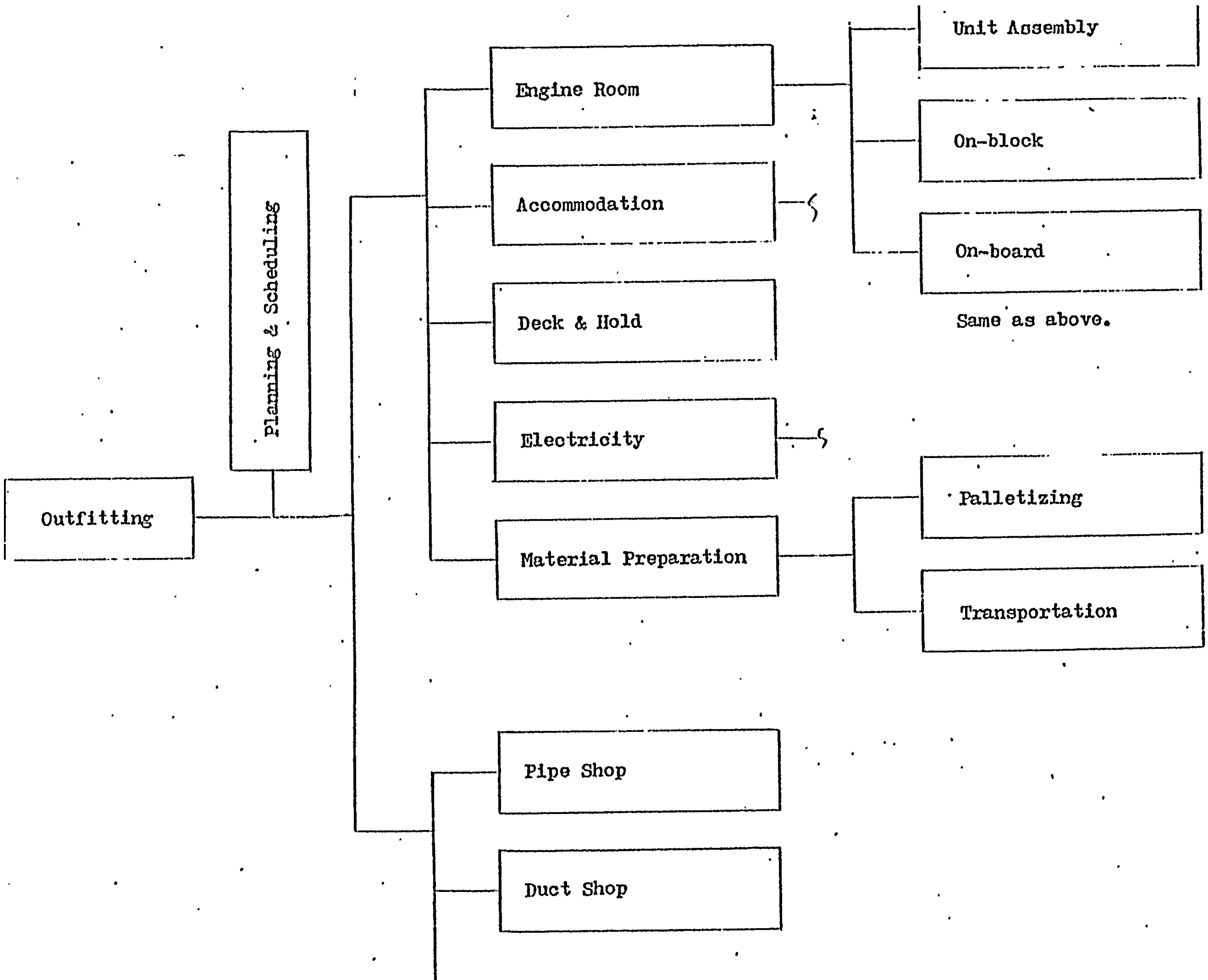
We merely make a synchronized interface between the end of manufacturing and the stare of outfitting, that is, completion of materials and palletizing.

Job territory of each section in a ship must be determined as clearly and simply as possible. For example, the boundary between the territories of engine section and deck section has to be set at one plane on or in parallel with the engine room front BHD as much as possible. In other words, organization should be zone-oriented.

By this organizations jobs in some zones can be completed by a minimum number of workers who belong to only one section, while the same must be accomplished by a larger number of workers who belong to more than two sections of a craftsmanship oriented organization. If. a zone is not large and jobs in a pallet are not complicated, the job's might be completed by only one able worker.

Today, it seems that well educated workers are requesting more educational opportunity and knowledge about their jobs. We called them "multi-job workers" who can do various kinds of jobs such as installation of piping, steel work, equipment, welding, gas cutting etc.

If we can successfully train a multi-job worker, we will be able to locate workers at certain zones and gain control with



Outfitting
Planning & Scheduling
Engine Room
Accommodation
Deck & Hold
Electricity
Material Preparation
Pipe Shop
Duct Shop
Unit Assembly
On-block
On-board
Same as above.
Palletizing
Transportation

Fig. 2-14

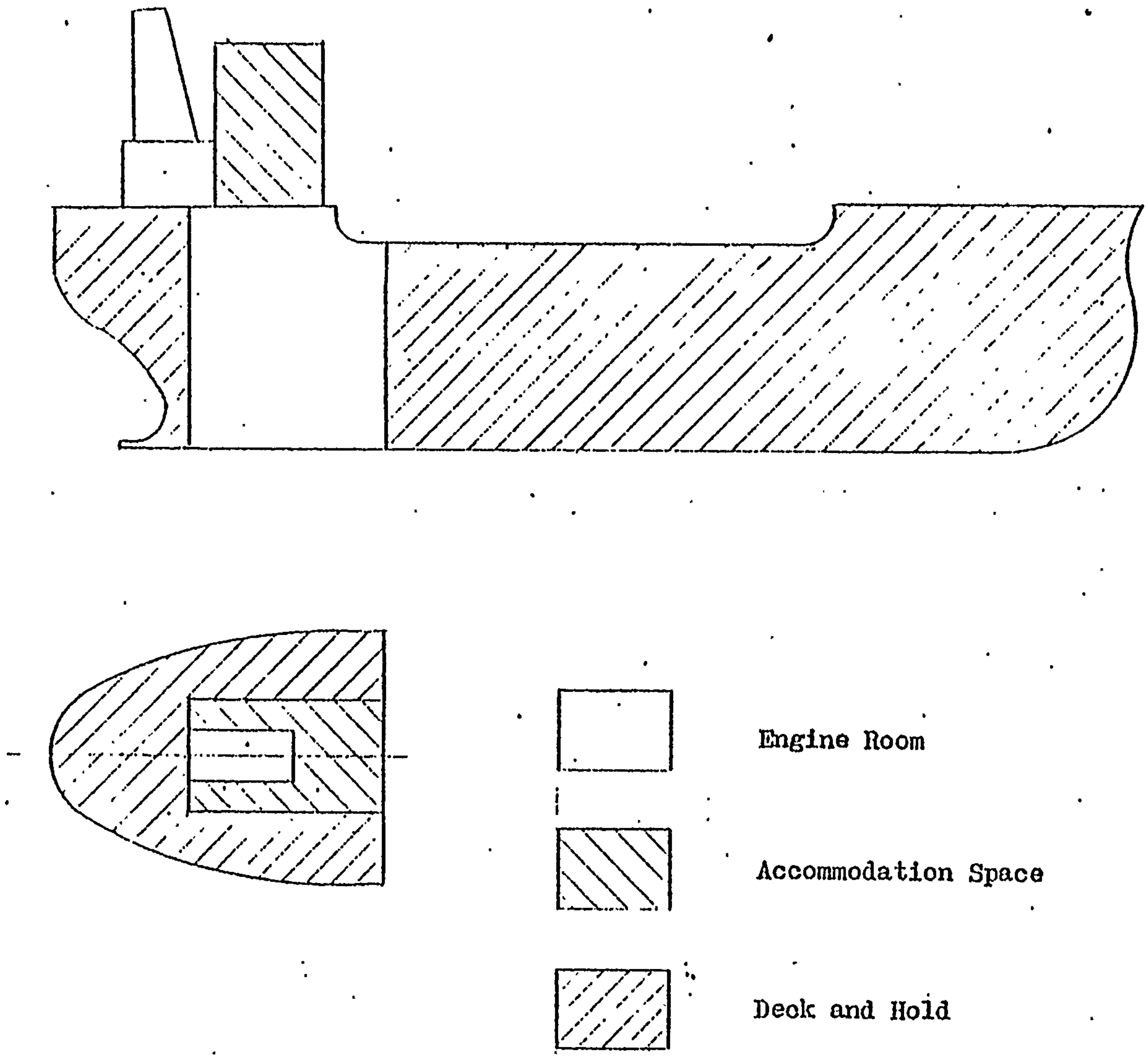


Fig. 2-15

high productivity. We call this idea “Fixed Place, Fixed Person” or "Multi-job System, ” which is one of the ideal organizations in the future.

4.2 Major Activity of Palletizing Planning (See ’Fig. 2-1)

1) Planning of Outfitting Method and Palletization

PPS engineers plan “how. to outfit” and make a primary guide for palletization, utilizing the following drawings and information.

General Arrangement
Machinery Arrangement
Functional Drawings
Hull Construction Drawings
Practice and Experience of Palletizing
Ship Construction Method”
Hull Block Segregation
Master Schedule etc.

First they match the segregation of outfitting zones and pallet zones with the hull block. assemblies taking.into account the following:

- Scope of units - size and number of unit, machine and adjacent piping to be assembled, etc.
- Sequence of jobs (materials) for each on-unit, on-block, onboard outfitting

- "Miscellaneous details

Following is an example of an engine room lower flat:

- How does the engine room segregate into zones?
- Is the large unit outfitting method applied?
- How is the main engine installed?
- How are the auxiliary machines assembled into the units together with adjacent piping and other materials?
- In what sequence are they installed?
- By what stage are they installed?
- How are the other materials palletized?

After the above study, they prepare "Orientation of Palletizing," "Pallet List" and "Pallet Schedule." "Orientation of Palletizing" indicates "how to outfit." Namely, it contains detailed zoning of the ship (Fig. 2-16), pallet definition for each stage (Figs. 2-17, 2- and guidance for materials to be preferably outfitted at each stage with some sketches, if necessary, etc. "Pallet List" lists all pallets which are to be used in the ship. See Fig. 2-19. "Pallet Schedule" shows the required date for each pallet, which is used for drawing issue schedule and material procurement. See Fig. 2-20. These information are sent to the design engineers who develop the preliminary composite drawings. Since this planning is performed at a very early stage, "Pallet List" and "Pallet Schedule" may be updated in subsequent stages.

Fig. 2-16 Zoning of Machinery Part
(For the detail, refer to Chapter V)

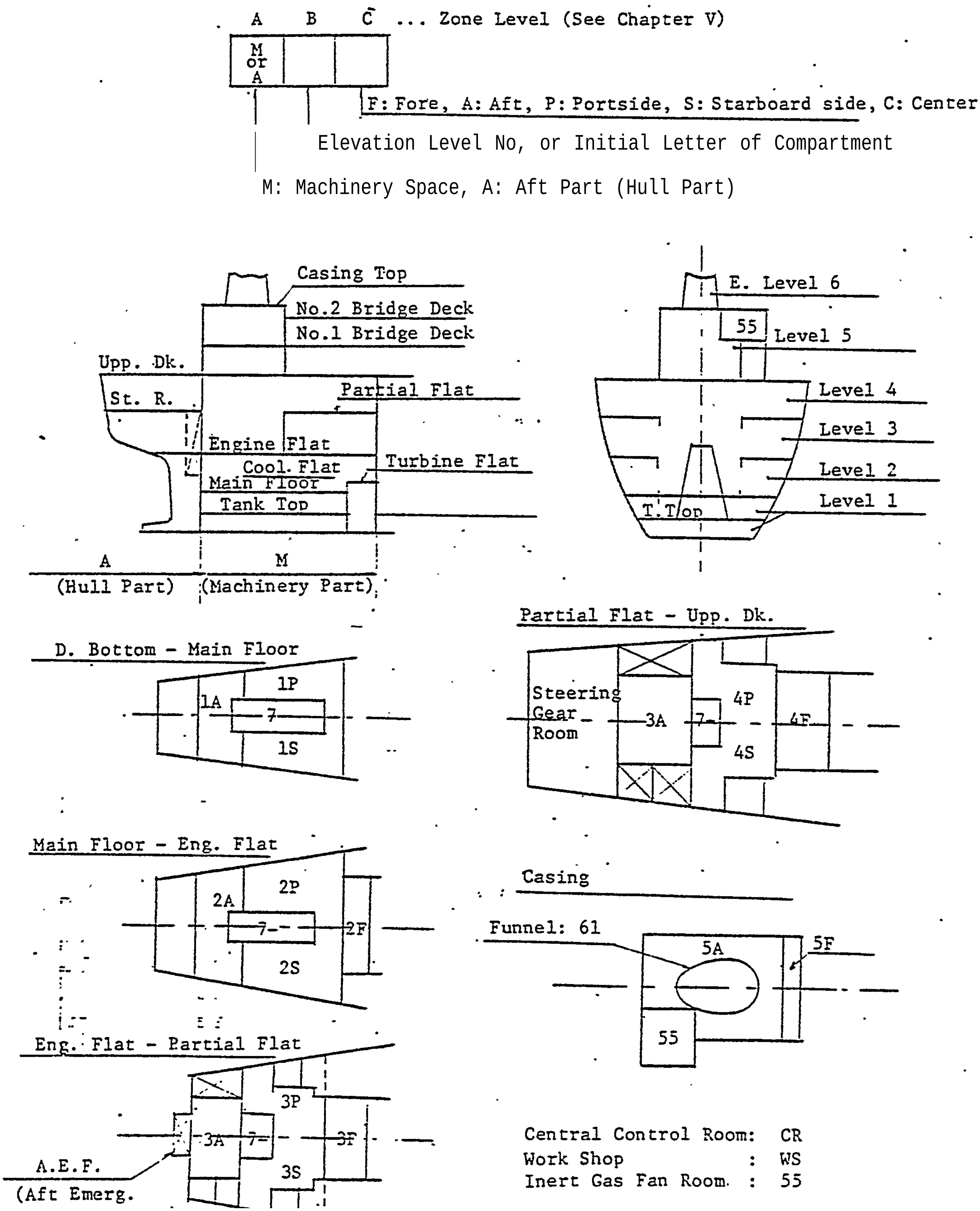
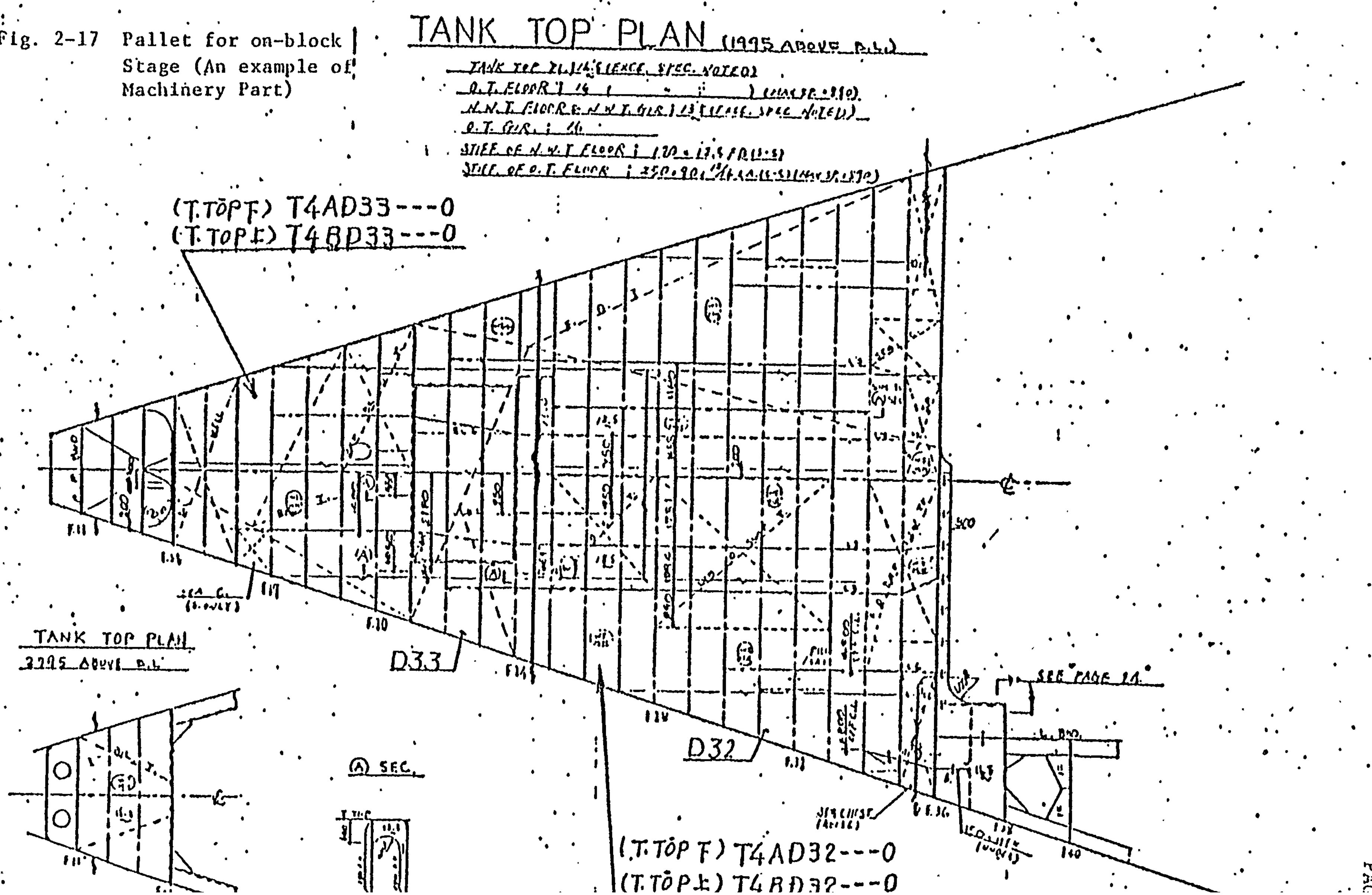


Fig. 2-17 Pallet for on-block Stage (An example of Machinery Part)



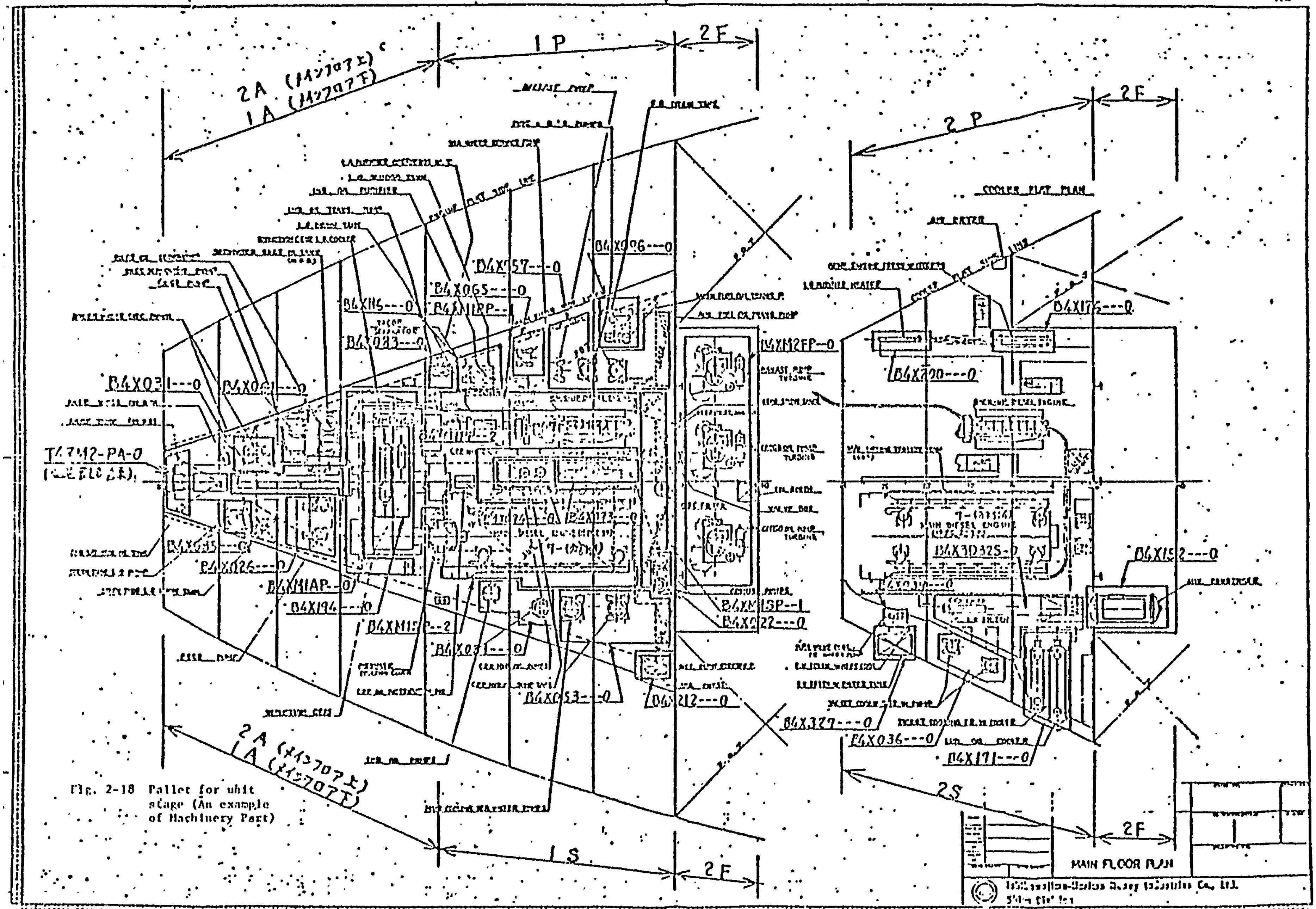


Fig. 2-18 Pallet for unit stage (An example of Machinery Part)

Fig. 2-19 (1/4)

PALLET LIST

PART: MACHINERY

STAGE: ON-BLOCK (PIE

MLF. No. 1	2	3	4	5	6	7	8	9	10	DESCRIPTION	NEXT ST (MLF. N 1	2	3	4	5	6
T	4	A	D	3	2	-	-	-	0		T	4	Z	M	1	S
T	4	A	D	3	2	-	-	-	0		T	4	Z	M	1	A
T	4	B	D	3	2	-	-	-	0		T	4	Z	M	1	S
T	4	B	D	3	3	-	-	-	0		T	4	Z	M	1	A
T	4	A	3	C	3	1	-	-	0		T	4	Z	M	2	[illegible]
T	4	A	3	C	3	2	-	-	0		T	4	Z	M	2	S
T	4	A	3	D	3	2	S	-	0		T	4	Z	M	2	S
T	4	A	3	D	3	3	S	-	0		T	4	Z	M	2	A
T	4	A	3	D	3	2	P	-	0		T	4	Z	M	2	[illegible]
T	4	A	3	D	3	3	P	-	0		T	4	Z	M	2	[illegible]
T	4	B	M	S	1	-	-	-	0		T	4	Z	M	1	[illegible]
T	4	B	D	G	1	-	-	-	0		T	4	Z	M	1	[illegible]
T	4	G	3	D	3	2	S	-	0		T	4	Z	M	2	[illegible]
T	4	G	3	D	3	3	S	-	0		T	4	Z	M	2	[illegible]
T	4	G	3	D	3	2	P	-	0		T	4	Z	M	2	[illegible]
T	4	G	3	D	3	3	P	-	0		T	4	Z	M	2	[illegible]
T	4	A	S	L	3	2	S	-	0		T	4	Z	M	2	[illegible]
T	4	A	S	L	3	3	S	-	0		T	4	Z	M	2	[illegible]
T	4	A	S	L	3	2	P	-	0		T	4	Z	M	2	[illegible]
T	4	A	S	L	3	3	P	-	0		T	4	Z	M	2	[illegible]

REMARKS: (CONTINUED)

Fig. 2-19 (2/4)

PALLET LIST

PART: MACHINERY

STAGE: ON-BLOCK (PIPING UNIT)

MLF. No. 1	2	3	4	5	6	7	8	9	10	DESCRIPTION	NEXT STAGE (MLF. No.) 1	2	3	4	5	6	7	8	9	10
B	4	X	3	D	3	2	S	-	0		T	4	A	3	D	3	2	S	-	0
B	4	X	3	D	3	3	P	-	0		T	4	A	3	D	3	3	P	-	0
B	4	X	S	U	3	3	S	-	0		T	4	A	S	U	3	3	S	-	0
B	4	X	U	C	3	2	-	-	1		T	4	A	U	C	3	2	-	-	0
B	4	X	U	C	3	2	-	-	2		T	4	A	U	C	3	2	-	-	0
B	4	X	U	S	3	3	S	-	0		T	4	A	U	S	3	3	S	-	0

REMARKS:

Fig. 2-19 (3/4)

PALLET LIST

PART: MACHINERY STAGE: ON-BOARD (MACH. UNIT

MLF. No.										DESCRIPTION	NEXT STAGE (MLF. No.)								
1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9
B	4	X	0	2	2	-	-	-	0	Aux. Circulating Water Pump	T	4	Z	M	1	S	F	A	-
B	4	X	0	2	6	-	-	-	0	Feed Water Pump	T	4	Z	M	1	A	F	A	-
B	4	X	0	3	1	-	-	-	0	Boiler Circulating Water Pump	T	4	Z	M	1	A	F	A	-
B	4	X	0	5	3	-	-	-	0	Cooling Sea Water Pump	T	4	Z	M	1	S	F	A	-
B	4	X	0	5	7	-	-	-	0	Fire & General Service Water Pump	T	4	Z	M	1	P	F	A	-
B	4	X	0	6	1	-	-	-	0	Bilge Water Pump	T	4	Z	M	1	A	F	A	-
B	4	X	0	6	5	-	-	-	0	Sea Water Service Pump	T	4	Z	M	1	P	F	A	-
B	4	X	0	8	1	-	-	-	0	M/E L.O. Pump	T	4	Z	M	1	S	F	A	-
B	4	X	0	8	3	-	-	-	0	L.O. Transfer Pump	T	4	Z	M	1	P	F	A	-
B	4	X	0	8	5	-	-	-	0	S/T L.O. Pump	T	4	Z	M	1	A	F	A	
B	4	X	0	9	3	-	-	-	0	R/G L.O. Pump	T	4	Z	M	1	P	F	A	-
B	4	X	0	9	4	-	-	-	0	C.P.O. L.O. Pump	T	4	Z	M	1	P	F	A	-
B	4	X	0	9	6	-	-	-	0	Main F.O. Transfer Pump	T	4	Z	M	1	P	F	A	-
B	4	X	1	1	6	-	-	-	0	L.O. Purifier	T	4	Z	M	1	P	F	A	-
B	4	X	2	1	2	-	-	-	0	Evaporator Ejector Pump	T	4	Z	M	1	S	F	A	-

Fig. 2-19 (4/4)

PALLET LIST

PART: MACHINERY

STAGE: ONBOARD (PIPE FITTINGS)

MLF. No.										DESCRIPTION	NEXT STAGE (MLF. No.)									
1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10
T	4	Z	M	-	-	P	-	-	0	Pipe Joint Covers										
T	4	Z	M	2	-	P	A	-	0	Stern Tube L.O. Piping System										
T	4	Z	M	3	-	P	A	-	0	- Do -										
T	4	Z	M	1	S	P	-	-	0											
T	4	Z	M	1	P	P	-	-	0											
T	4	Z	M	1	A	P	-	-	0											
T	4	Z	M	2	F	P	-	-	0											
T	4	Z	M	2	S	P	-	-	0											
T	4	Z	M	2	P	P	-	-	0											
T	4	Z	M	2	A	P	-	-	0											
T	4	Z	M	3	F	P	-	-	0											
T	4	Z	M	3	S	P	-	-	0											
T	4	Z	M	3	P	P	-	-	0											
T	4	Z	M	3	A	P	-	-	0	(Boiler Space)										
T	4	Z	M	4	F	P	-	-	0											
T	4	Z	M	4	S	P	-	-	0											
T	4	Z	M	4	P	P	-	-	0											
T	4	Z	M	5	F	P	-	-	0											

MLF. NO. 管 理 表

MLF. NO. 出図依頼表

5/0106 DATE=78,10,17

ジ No		大区画	搭載日	取付図番		管(電線) 本数(M)	重量	取付重量 部品外(kg)	部品(kg)	作業開始日	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
	7	11	781124	ZA02	1					781124								D		A	C	
	7	11	781206	ZA02	2			160		781206									D	A		C
	7	11	781127	ZA02	5			18		781127									D	A	C	
	7	11	781127	ZA02	6					781127									D	A	C	
	7	11	781206	ZA02	7			660		781206									D	A		C
	7	11	781127	ZA02	10					781127									D	A	C	
	7	11	781127	ZA02	11					781127									D	A	C	
	7	11	781206	ZA02	12					781206									D	A		C
	7	11	781128	ZA02	14					781128									D	A	C	
	7	11	781128	ZA02	15					781128									D	A	C	
	7	11	781211	ZA02	16			154	166	781211									D		A	C

所要日予定表(A:出図予定 B.出庫日 C.搭載日 D.MLF投入日)

Fig. 2-20. (2/2) **Itemized Description of Pallet Schedule**

1. *MLF No:*
2. Following Stage (MLF No., Used for a unit)
3. Temporary Location Zone
4. CIII, Sign for alteration; 1:, Partial Revision, 3: Deletion .
5. Responsible Outfitting Shop
6. Zone for Material Procurement
7. Installation Date
8. Working Drawing No.
9. 9-1: Number of pipes or electric cables
   9-2: Weight of pipes or electric cables
10. Installation Weight, 10-1: Control weight which is in proportion to outfitting manhour
    10-2: Other weight than control weight
11. Starting Date of Installation .
12. Revision No. of Pallet Schedule
13. Revision No. of Design
14. Schedule, A: Drawing Issue Date, B: Material Issue Date, C: Installation Date,
    D: Input Date of MLF Data (to Computer)
15. Ship No.
16. Responsible Design Section
17. Authorization
18. Distribution

2) Review of palletizing

After receiving the pre-composite (= preliminary) drawings from design engineers, PPS engineers review them to determine whether the pre-composite drawings are developed as previously indicated by "Orientation of Palletizing." Furthermore, they check the drawings with regard to several points with which PPS engineers must be more familiar than are design engineers. Checking safety of installation is especially important to PPS engineers.

- Is the design (arrangement) workable at operation and maintenance? e.g., arrangement of handle, space for operation, height of handle, etc.
- Are lifting eyes located at a position so that lifting wires on them will not cause damage to outfitting materials when they are lifted and turned over?
- Do hull blocks have space for rests for storing after all materials are installed?
- Are all jobs accomplished safely?
- Can scaffolding be prepared firmly and safely?

After review of pre-composite drawings, PPS engineers send them back to the design engineers for development of composite drawings.

3) Review of Composite Drawing

After receiving the composite drawings from design engineers, PPS engineers review them to determine whether the composite drawings have been developed as requested. They then check all machinery units, piping units, other units, pipe spools,. grating, and a1l other materials, piece-by-piece.. They carefully check pieces which are located on or near segregation between pallets, because these pipes will sometimes affect onboard outfitting productivity. For example:

On Fig. 2-21, when planning of the pump unit, we usually want to put the valve manifold together with the pump, because it is a part of the pump unit. If we do so, boundary between the pump unit and the pipe and grating unit (pallet) becomes B. Then 6 pieces of pipe spools 1, 2, 3, 4, 5 and 6 go to an onboard unit, which requires connection of pipes and the manifold onboard. But if we put it into the pipe and grating unit (pallet), the-boundary becomes A. Then pieces 1 to 6 go to an onboard unit, i.e., connection of pipes and the manifold can be done in the unit assembly shop. Besides, installation of piece 7 is much easier than under grating pipe pieces 1, 2, 3, 4, 5 and 6 if carried out onboard. On Fig. 2-22, the hull block B is loaded after A, as their joints indicate.

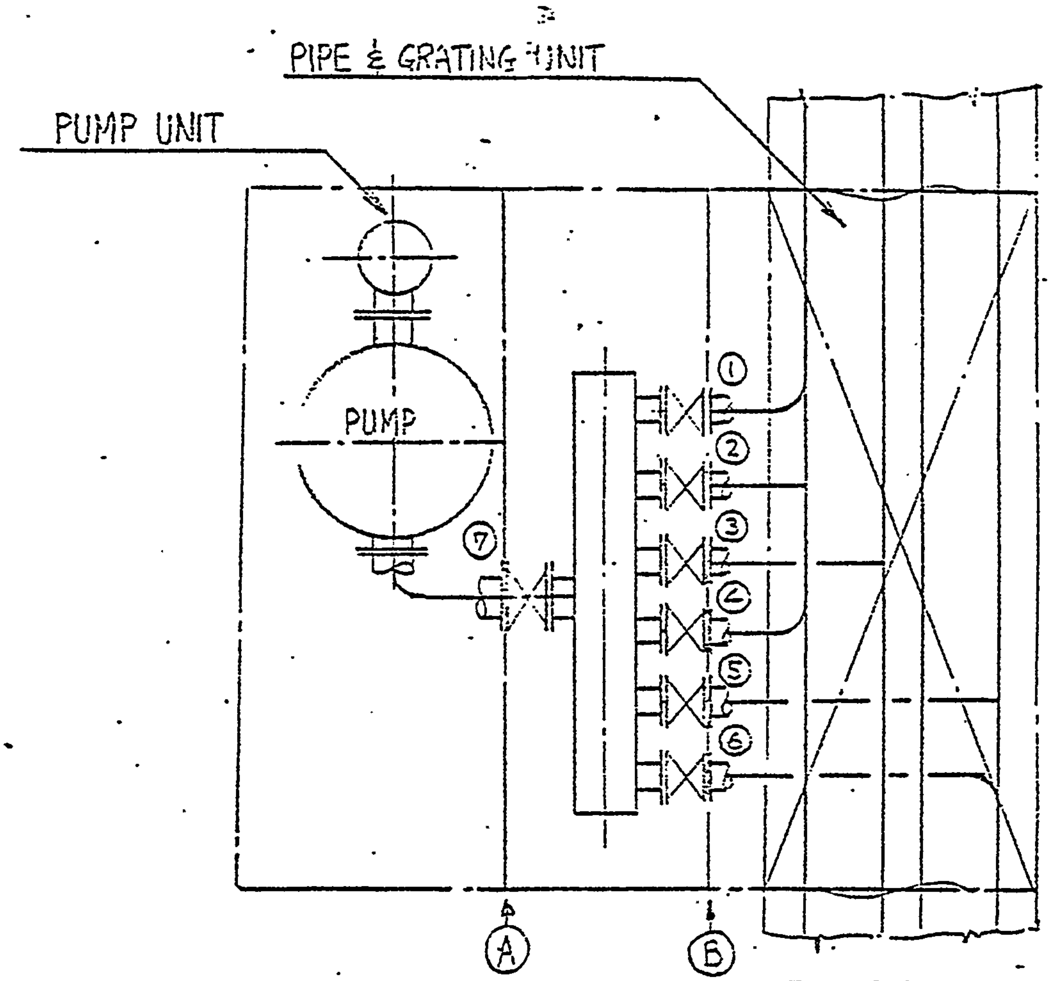


Fig. 2-21

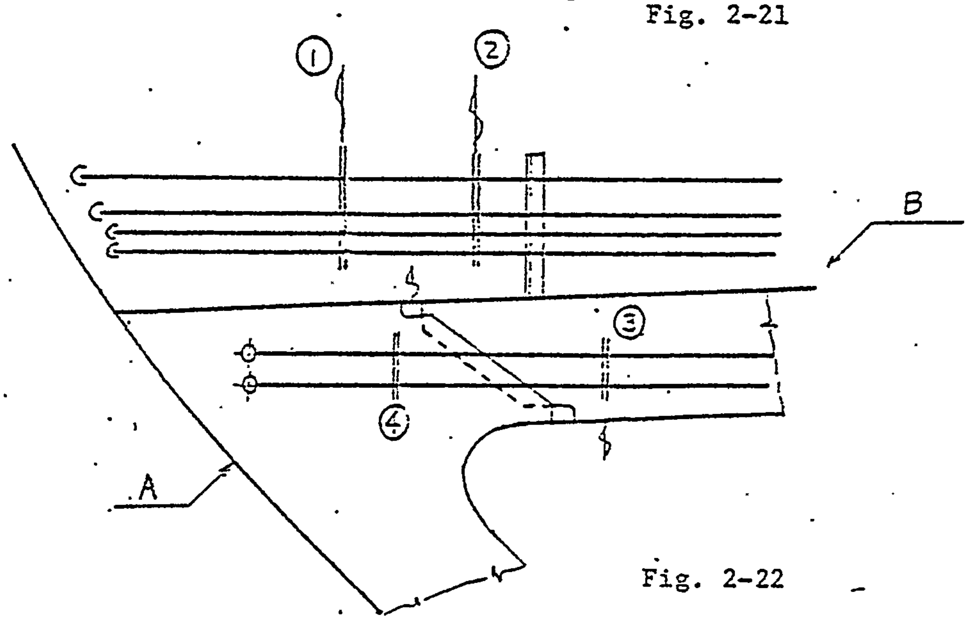
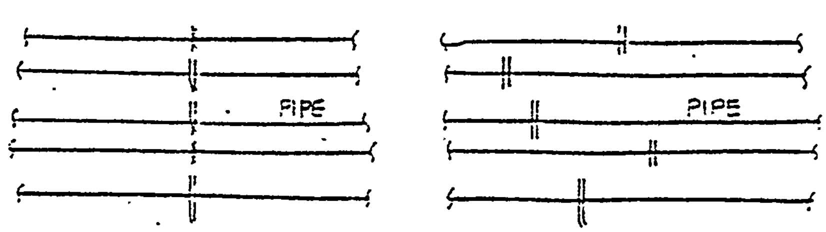


Fig. 2-22



Then, joints of pipes have to be 1; if they are 2, the hull block plate edge has to insert between the, pipes of block A and pipes when loading. In connection with the hull block joint, the pipe joints must be given at 3 and 4, and the pipe between 3 and 4 is installed on-board as a make-up pipe. Otherwise the piping that is already installed at the on-block.stage disturbs welding for the web joint. On Fig. 2-23, lined joints are better. than zig-zag joints for ease of unit installation.

4.3 Material Marshalling and Palletizing

1). Role of Material Preparation Group

The role of the Material Preparation Group is to assure the-best supply of materials. to the production department from the material department in a timely manner. It is one of the most important jobs in the process of palletization because, as we have discussed, the best material preparation will result in the best productivity.

Therefore, the role is not limited to the palletizing and transportation of materials but also includes expediting and communicating about material and material preparation with the design engineers as well as PPS engineers. Materials which might be delayed are always picked up and

expedited together by an expediter in the Material Procurement Dept. When it is found cl-tat the delay is unavoidable the PPS engineer is informed so that he can reschedule the outfitting work to meet the delay. Flow of material preparation is shown in Fig. 2-24.

2) Organization (Example of IHI Kure Shipyard)

As shown in Fig. 2-25, the Material Preparation Group is subdivided into five groups. Four of them correspond to the subdivisions of the Outfitting Dept., so that' each group can closely communicate with its corresponding subdivision about material preparation. The-spare parts group takes care of spare parts independently so as not to disturb palletizing, because handling of spare parts is a troublesome job at the end stage.

Transportation is operated by one independent group for efficient and safe operation of carriers.

In IHI Kure Shipyard the material preparation group belongs to the Outfitting Production Dept. But this group can alternatively belong to the warehouse. Advantage and disadvantage in this case are:

- Being able to save manhours for marshalling and palletizing thanks to good communication within the warehouse dept.

- Being liable for poor communication with PPS engineers and production site.

3) Material Pteparation

Each group gathers information for material preparation and takes actions such as:

- Preparing requests for scheduling of working drawing and "Material List of Pallet," referring to production schedule, lead time of materials and feedback data. (actual situation of material preparation in the last ship).

- Expediting materials to meet palletizing schedule.

- Communicating production schedule changes to material control engineer in order to adjust material receiving schedule.

- Informing PPS engineers of delayed materials and making tentative changes in the palletization schedule to meet changes caused by the delay.

4) Inspection (proposed)

When materials arrive,. inspection is carried out for each item material by referring to the drawings. If a defect is found,. that material is sent back to the vendor or manufacturing shop and re-receipt date is determined.

When the pallet of that material has already been issued, excluding that material, re-receipt date is communicated to the PPS enginers

5) . Palletizing

Materials are palletized as follows:

0 When delivery date of pallet indicated in the latest monthly schedule is received, material issue from the warehouse and manufacturing shop of the pallet is requested (pallet-by-pallet).

o The-warehouse and manufacturing shop issue materials pallet-by-pallet, referring. to "Material List Of Pallet" with "List of Missing Material."

o These materials from the warehouse and the manufacturing-shop are combined into one pallet.

o A daily pallet transportation schedule is prepared and sent to the transportation group.

o Missing materials which should have been contained in the pallet that has already been delivered are expe ed and sent to the production site when received.

6) Transportation

Pallets are transported to the area which was previously determined near on-unit outfitting and on-block outfitting site, or to the spot on deck, hold, accommodation, engine room near onboard outfitting site.

7) Marshalling Area

Since outfitting materials vary in size, type, weight, quality, etc., a relatively large area is required for effective palletizing. The area should be *as. close* to both warehouse-and outfitting area as possible. If impossible, it should be close to the warehouse. Fig. 2-25 also shows the area used in IHI Kure Shipyard.

8) Facilities

The marshalling area is provided with cranes with light lifting capacity and rapid travelling speed. Also, considerable number of fork lifts or pallet carriers are required. Fig. 2-25 shows the crane and carrier used in IHI Kure Shipyard.

MATERIAL PALLETISING FLOW

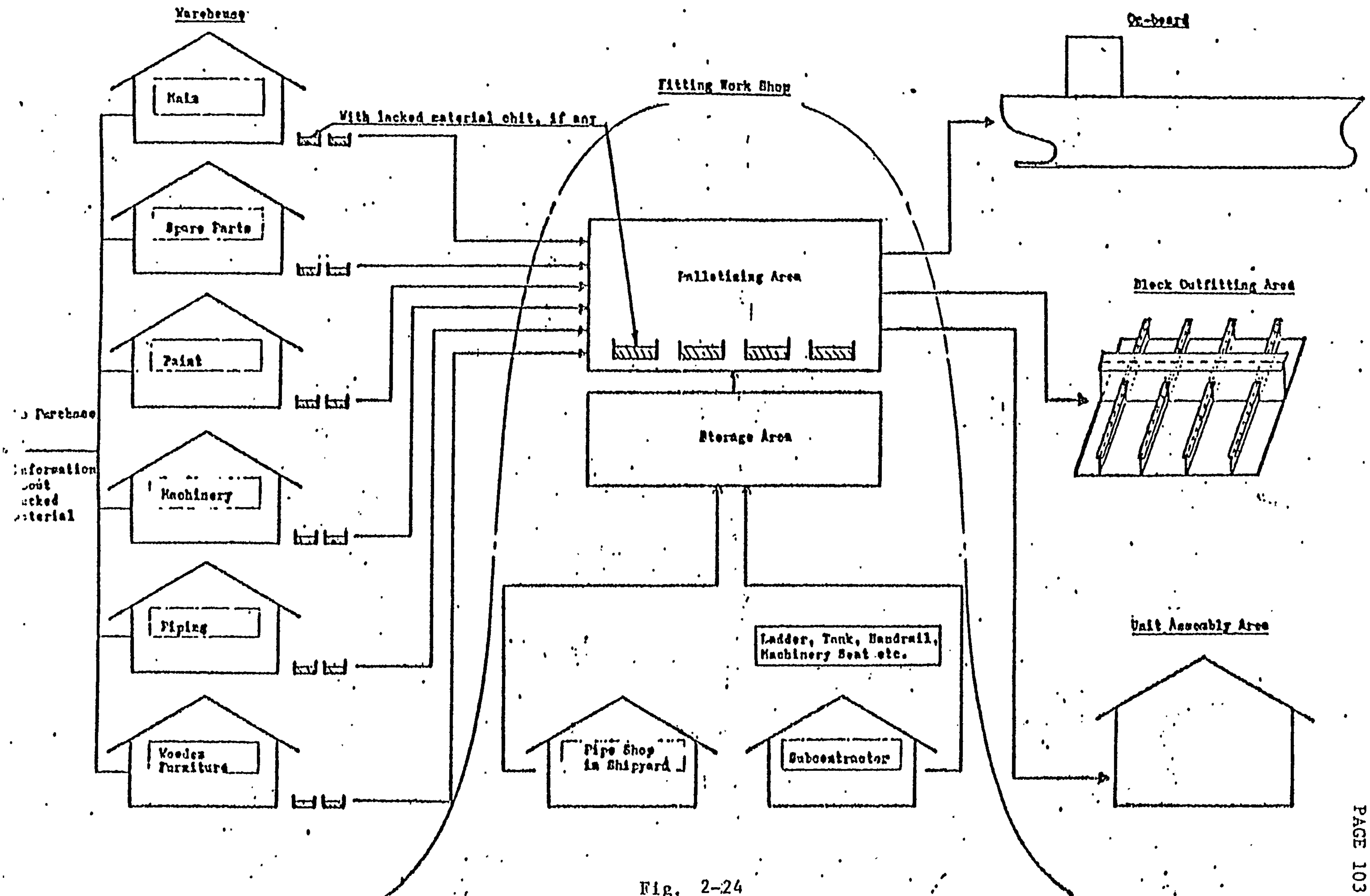


Fig. 2-24

- Material Preparation
  - Palletizing
    - Deck
    - Engine
    - Accommo. & Electric.
    - Spare parts
  - Transportation

	Deck	Engine	Accommo. & Electric.	Spare parts	Transportation
No. of Workers	6	5	6	5	8
Marshaling Area	5456 m^2		2089 m^2		
Facilities	10 ton Crane - 1 2 ton Crane - 1 1 ton Crane - 1		2.8 ton Crane - 1		Tractor 4 Mobile Crane 3.5 ton 1 Fork Lift 6 Pallet Carrier 10 ton 2 6 ton 34 4 ton 4 3 ton 19 Mobile Truck 6

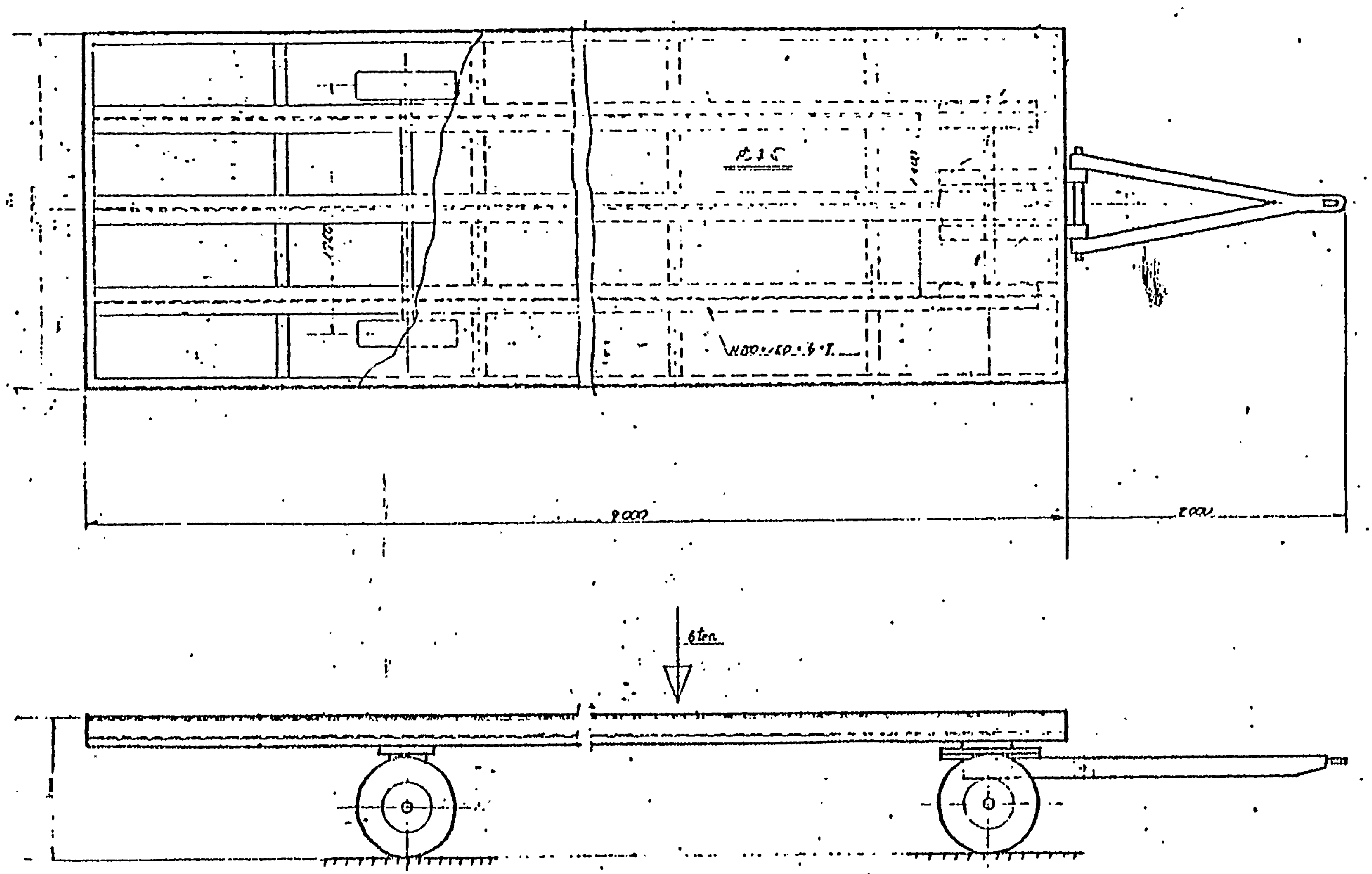
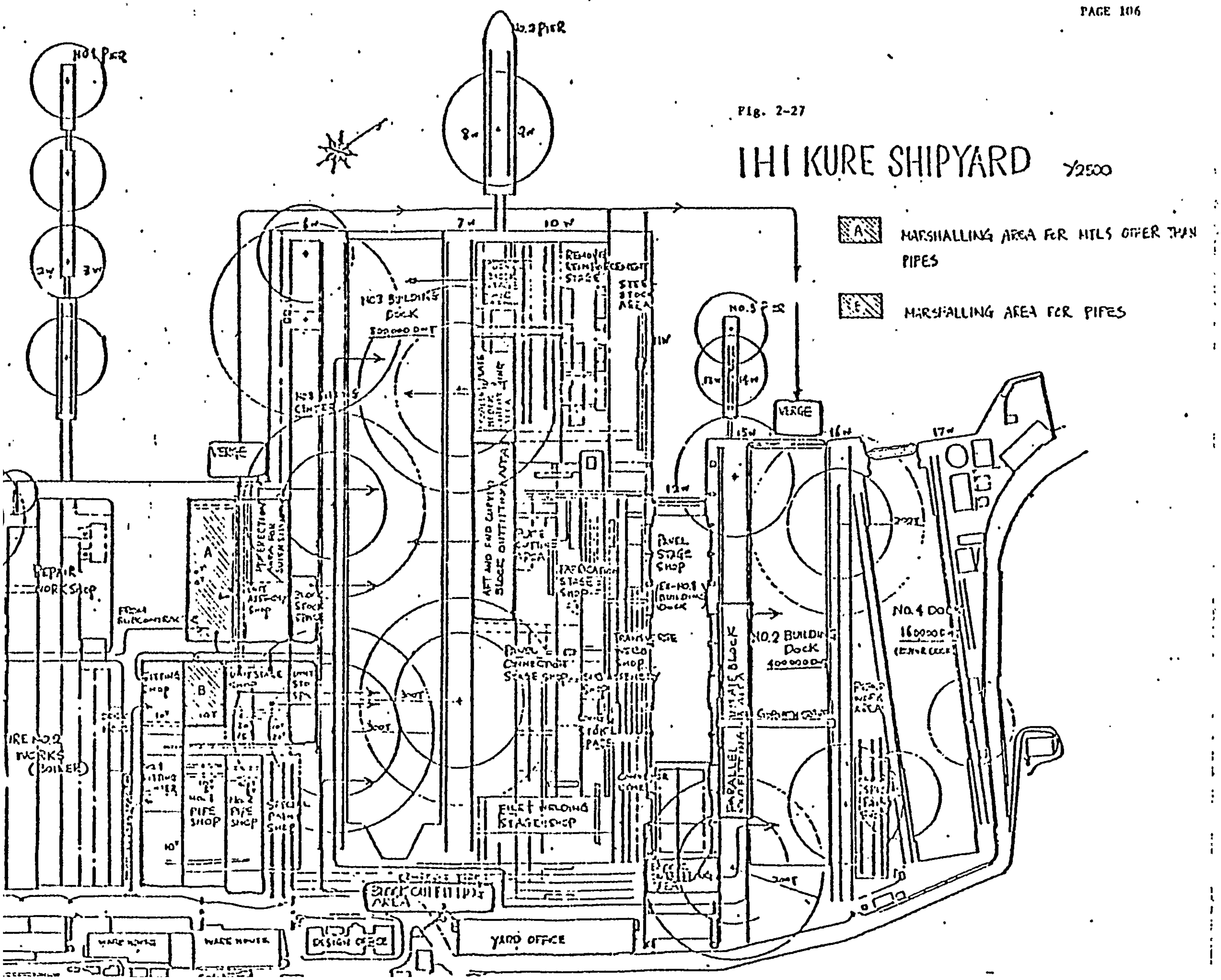


Fig. 2-26 Pallet Carrier (6 Ton type)

Fig. 2-27

IHI KURE SHIPYARD 1/2500



Following three chapters introduce the IHI's standards related. to Palletization;

CHAPTER III ZONING AND SYMBOL MARK

CHAPTER IV ML(F) AND FORM OF MLF-NO. (GENERAL)

CHAPTER V CODING GUIDANCE OF MLF-NO. (MACHINERY PART)

CHAPTER III- ZONING AND SYMBOL MARK

1. Composition of Zone Symbol

Level A	Level B	Level C

1.1 Level A

Level A defines the zones of the first level re-presenting the outfitting part or structure of a ship, such.as upper deck, shell, fore section, machinery space, Iiving quarters, pump room, etc. The initial letter (English). of each zone is usually used *as* the symbol mark.

1.2 Level B

Level B defines the subdivision. of Level A.

There are two types in zones of Level B, i.e., general zone and special zone.

A special zone is a zone whose location is changeable due to owner’s requirement of design improvement.

A general-zone is a zone other than the special zone. A general zone is given a sequential number as its symbol to. show its fore-aft location in the zone of Level A and a . special zone its initial letter.

1.3 Level-C

Level C is the subdivision of Level B and defines the location in the zone of Level B.

The following five types (symbols) of zone are at Level C.

P .... Port side

S .... Starboard side

C .... Center

F .... Foreside

A .... Aft side

In case there are two or *more* special zones with the same name, a sequential number shall be assigned for Level C, and in case of only one special zone for. one name, an alphabetical letter to give some-significance to its superior zone of Level B may be placed in the column of Level C.

1.4 Examples

a) General zone

Level A	Level B	Level C
U	2	P
Upper-deck	Second from fore	Port side

b) Special zone

Level A	Level B	Level C
L	F	S
Living accommodation	Fan room	Starboard side

2. Zones and Symbols of Level A

2.1 Fore part "F"

All zones forward of the aft bulkhead of the fore peak tank except shell plate.

2.2 Shell Plates "S"

All hull shell plate. This zone is used for outfitting of sea chests, cathodic protection, zincs, marks (draft marks, etc.) on the shell plates.

2.3 Upper Deck "U"

Upper deck between the aft bulkhead of fore peak tank and fore end of accommodation superstructure.

2.4 Aft Part "A"

All zones aft of the aft end bulkhead of engine room except shell plates.

2.5 Weather Part of Accommodation "W"

Weather part of all accommodations including upper deck side by the acdommodation and engine casing; the top and wall of engine casing *are* not included in "W".

2.6 Weather Part of Engine Casing "E"

Weather part of the top and wall of engine casing.

2.7 (Living) Accommodation "L"

All inside zones of the accommodation.

2.8 Machinery Room "M".

Machinery (main engine) room, all inner zones of engine casing and funnel.

Emergency generator room and inert gas fan room side by the engine casing, if any, are included in "M". Stores, recreation room, pool, etc., side by the engine casing are included in "E".

2.9 Pump Room "P"

All inside zones of pump room including the entrance.

2.10 Hold Part

a) Tanker . . . . "T".

All inside zones of cargo tanks and slop tanks.

b) B/C, O/C, P/C

1) Wing tank, slop tank . . . . . . "T"

2) Cargo hold . . . . "H" .

3) Double bottom tank and duct keel .... "B".

c) Container ship

1) Side tank .... "T"

2) Cargo hold .... "H"

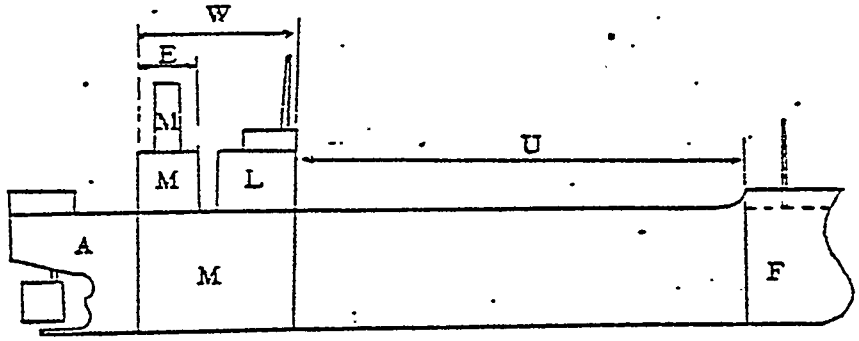
2.11 Double Bottom "B"

Zones in double bottom.

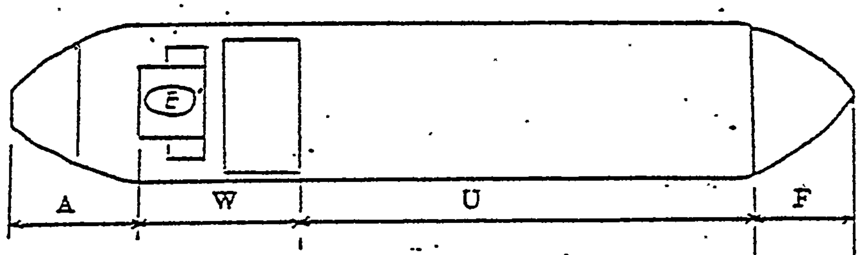
2.12 Overall "Z"

Zones relating to all parts of the ship.

Zoning of Level A

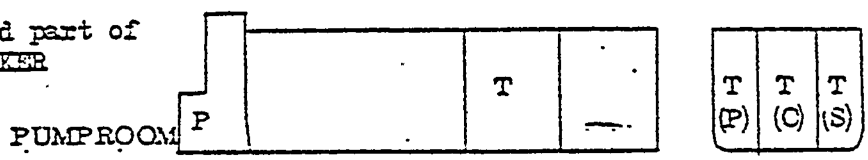


All shell plates : S

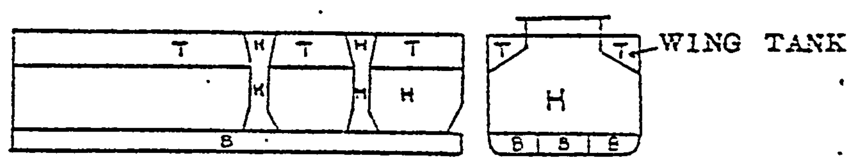


(Upper deck & weather part)

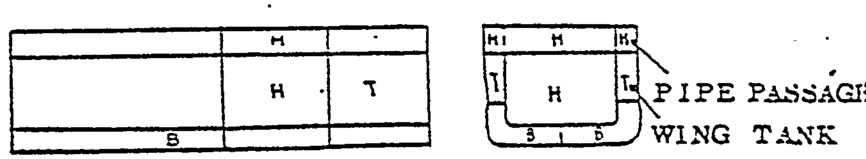
Hold part of TANKER

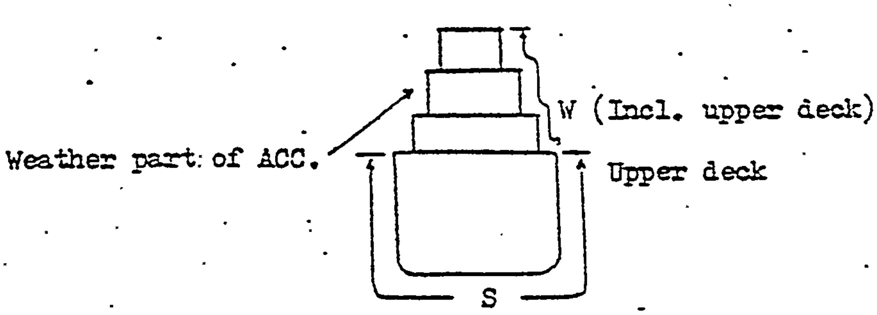


Hold part of
O/O, O/B
BULK/C, CARGO/C



Hold part of
CONTAINER SHIP.

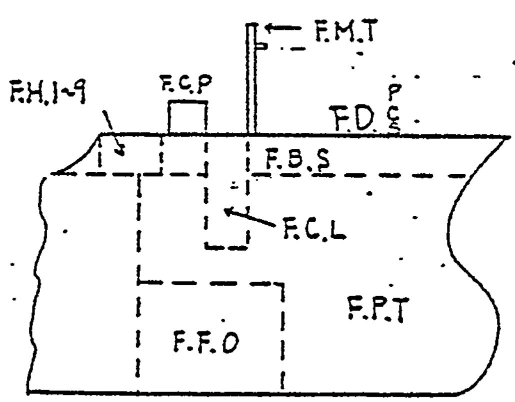




3. Zones and Symbols of Level B and C

3.1 Fore part "F"

Zone \ Col. of MLF No. / Level	4 A	5 B	6 C	Remarks
FORE PEAK TANK	F	P	T	* 1
FOR'D F.O. TANK		F	O	
WATER BALLAST T		W	B	
CHAIN LOCKER		C	L	
FOR'D PUMP ROOM		P	R	
BOW THRUSTER ROOM		B	T	
BOSUN STORE		B	S	
COMPANION		C	P	
FO'C'LE DECK		D	P S C	
HYDRO PUMP ROOM		H	1~9	* 2
FORE MAST	↓	M	T	* 1



Note: * 1. Not identified by P.S.C.

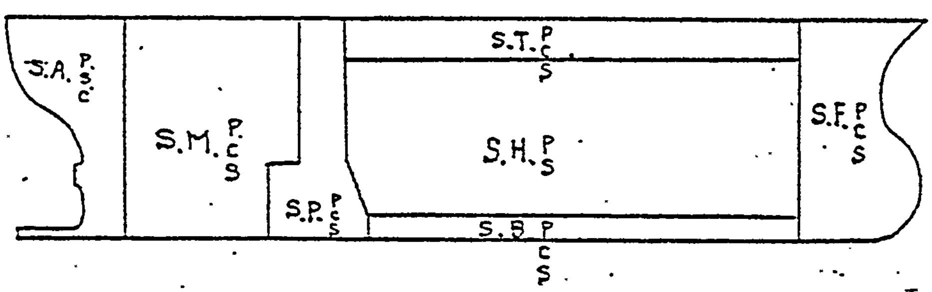
* 2. Numbering sequence of level C shall be from fore to aft and from S to P.

* 3. D ...... Hull part other than accommodation
M ..... Machinery part
E ..... Electric part
cf. A ..... Accommodation

3.2 Shell plates "S"

Col. of MLF-No. / Level / Zone	4	5	6	Remarks	Relevant parts
	A	B	C		
ALL SHELL PLATES	S	—	—	To be used for outfitting of sea chest, anode, marks, bottom plugs etc. If level C is not necessary col. 6 of MLF-No. shall be filled with hyphen "-"	D
FORE PART		F	P.C.S		E
PARALLEL PART (T)		T			
PARALLEL PART (B)		B			
PARALLEL PART (H)		H			
MACHINERY PART		M			
AFT PART		A			
PUMP ROOM		P			

Shell plate S



3.3 Upper Deck "U"

Zone \ Level \ Col. of MLF No.	4	5	6	Remarks
	A	B	C	
PARALLEL PART	U	1～9 U～Z A , B	P.S.C	Level B is numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to the arrangement of tanks and holds.
HYDRO PUMP ROOM		H	1～9	Level C is numbered 1-9 from fore to aft and from S to P.
DECK HOUSE		D		
MAST HOUSE		M		
DERICK POST		P		
LAMP POST		L		
CO_2 ROOM		N		
COMPANION		C		

Tanker

U.V.P	U.U.P	U.9.P					U.4.P			U.1.P
U.V.C	U.U.C	U.9.C				U.5.C				U.1.C
U.V.S	U.U.S	U.9.S			U.6.S					U.1.S

→ F

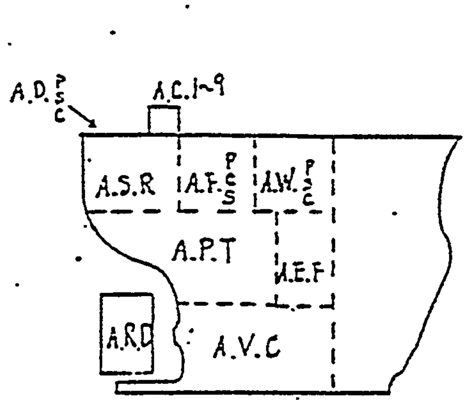
O/O, O/B/O, B/C. Container ship

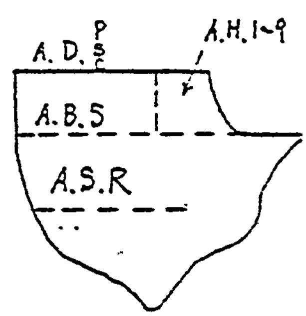
U.V.P		U.9.P					U.4.P			U.1.P
U.V.C		U.9.C				U.5.C				U.1.C
U.V.S		U.9.S			U.6.S					U.1.S

Note: Hatch cover is not treated as a zone.

3.4 Aft part "A"

Zone \ Col. of MLF No. / Level	4 A	5 B	6 C	Remarks	Relevant parts
BOSUN STORE	A	B	S	Level C is fixed and not identified by P.S.C.	
AFT UPP DECK		D	P.S.C		D
VOID SPACE (COOLING WATER TANK)		V			M
POTABLE WATER TANK		P			E
FRESH WATER TANK		F			
DRINK WATER TANK		W			
AFT PEAK TANK		P	T	Level C is fixed and not identified by P.S.C.	
EMERG FIRE PUMP ROOM		E	F		
HYD PUMP ROOM		H	1~9	Level C to be numbered from fore to aft and from S to P.	
REF MACH ROOM		R	F	Level C is fixed and not identified by P.S.C.	
RUDDER PLATE		R	D		
STEERING GEAR ROOM		S	R		
COMPANION		C	1~9		
DISTILLED WATER TANK		J	P/S		



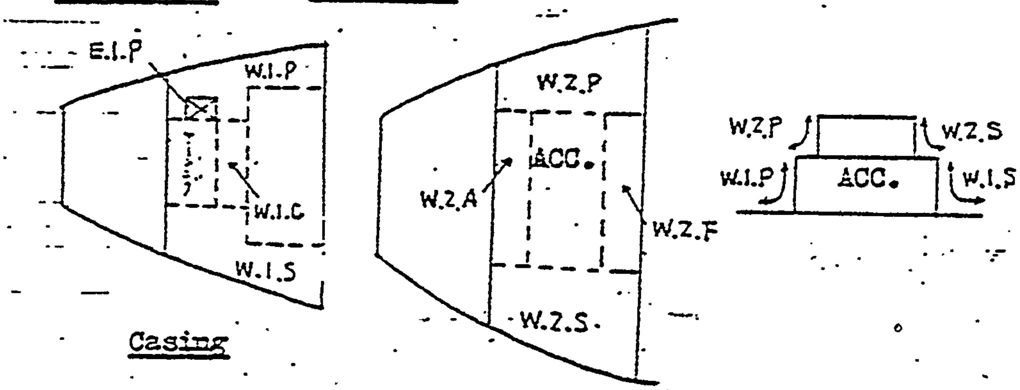


Note: Rudder tank to be included in A.P.T.

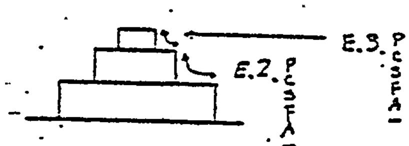
3.5 Weather part of accommodation and engine casing "W", "E"

Zone / Level (Col. of MLF No.)	4 A	5 B	6 C	Remarks
ALL ZONES	W	—	P.S.C A.F—	1. Level B : Tier 2. Level C : Location 3. "—" : All zone at the superior level
1ST TIER	↓	1	↓	
∫		∫		
7TH TIER		7	↓	
RADER MAST	↓	R	M	Level C is not identified by P.S.C.
ALL ZONE OF ENGINE CASING	E	—	P.S.C A.F—	1. Level B : Tier 2. Level C : Location 3. "—" : All zone at the superior level.
1ST TIER	↓	1	↓	
∫		∫		
7TH TIER	↓	7	↓	

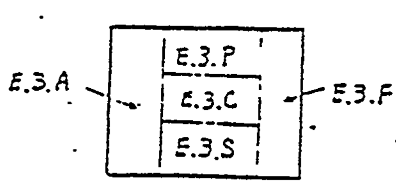
Upper Deck Boat Deck



Casing

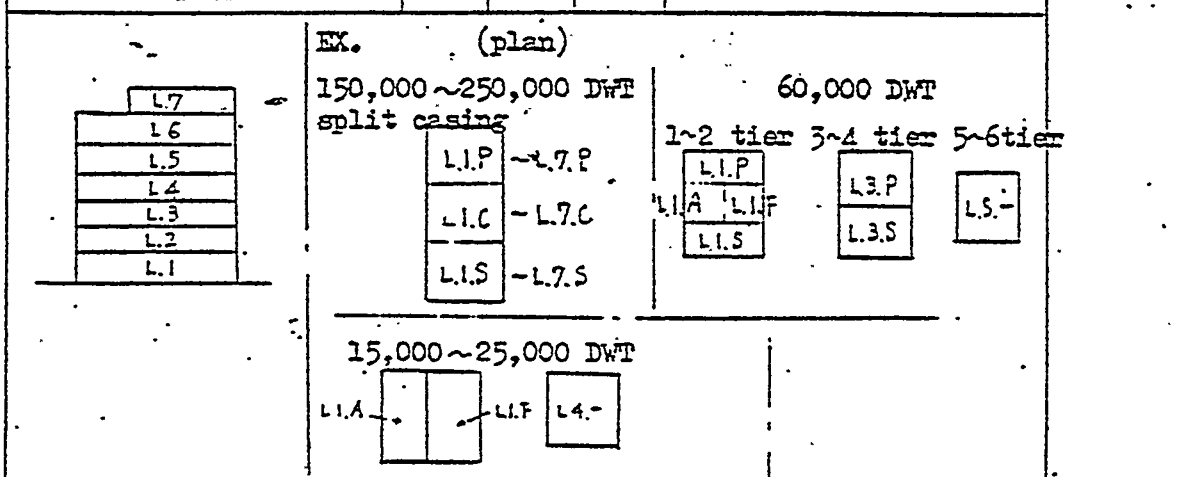


Casing top



3.6 (Living) Accommodation "L"

Zone \ Level \ Col. of MLF No.	4 A	5 B	6 C	Remarks	Relevant parts
ALL ZONES	L	—	P.S.C A.F	1. Level B : Tier 2. Level C : Location 3. "—" : All zone at the superior level	A
1ST TIER		1			
⁝		⁝			
7TH TIER		7			
BATTERY ROOM		B		1. Level B : Symbols to identify special zones 2. Level C : Location 3. "—" : All zone at the superior level	A D E
CARGO CARE ROOM		A			
CARGO OIL CONT ROOM		C			
CO_2 GAS ROOM		D			
ENGINE CONT ROOM		E			
EMERG GEN ROOM		J			
FAN ROOM (INCL. THERMO T.R)		F			
FOAM TANK ROOM		L			
GALLEY , PANTRY		G			
GYRO ROOM		K			
HYDRAULIK P.ROOM		H			
INERT GAS ROOM		N			
INNER PASSAGE		P			
REF.MACH.ROOM		M			
RADIO ROOM		R			
REF CHAMBER		Q			
WORK SHOP		S			
ELEVATOR SPACE		E	L	Not identified by P.S.C	
DUMB-WAITER SPACE		D	W	—	



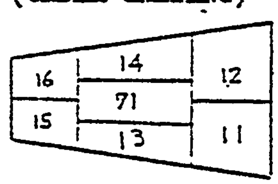
3.7 Machinery room "M"

Zone \ Level \ Col. of MLF No.	4 A	5 B	6 C
MAIN FLOOR (UNDER GRATING incl. GRT'G)	M	1	1～6 P S —
MAIN FLOOR — (ABOVE GRATING)		2	1～8 P S —
LOWER ENG FLAT	-	3	1～6 P S —
UPPER ENG FLAT		4	1～6 P S
ENGINE CASING (INSIDE)		5	1～4 P.S
INERT GAS FAN ROOM		5	5
EMERG GEN ROOM		5	6
FUNNEL (INSIDE, OUTSIDE)		6	1
AROUND M/E AFTER ERECTION		7	1
DIESEL ŌIL TANK		D	Ō
ENGINE CONT ROOM		C	R
FUEL OIL TANK		F	P.S.C
F.O. SETT TANK		S	P.S.C
WORK SHOP		W	S
ELEVATOR SPACE		E	L
DISTILLED WATER TANK	↓	J	P.S.C

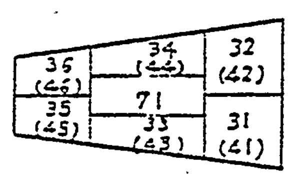
Remarks

1. Level B shows flats or decks in the engine ro
   In special zones, leve
   B is a significant alphabetical letter.
2. Level C defines P or S
   Odd number (1,3,5--)mea
   S and even number P.
   Eyen "-" means all are
   in the superior zone level.
3. Special examples
   (1) MIP ... All portsid zone of mai flour
   (2) M1-.... All area of main floor
   (3) Grouping of two zon
   M31 + M32 = M31
   (M31 represents the two zones)
   M11 + M21 = M21
   (M21 represents the two zones)

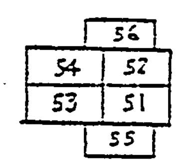
MAIN FLOOR (UNDER GRATING)



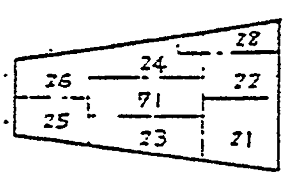
LOWER ENG. FLAT (UPP ENG. FLAT)



ENGINE CASING

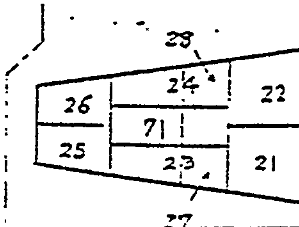


MAIN FLOOR (ABOVE GRATING) (DIESEL ENGINE) 28: COOLER FLAT



MAIN FLOOR (ABOVE GRATING) (TURBINE ENGINE

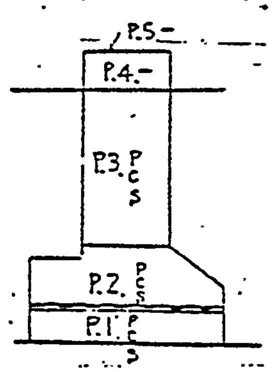
27, 28: OPERATI
21, 22: TURBINE



3.8 Pump room and Tank part of Tanker "P", "T"

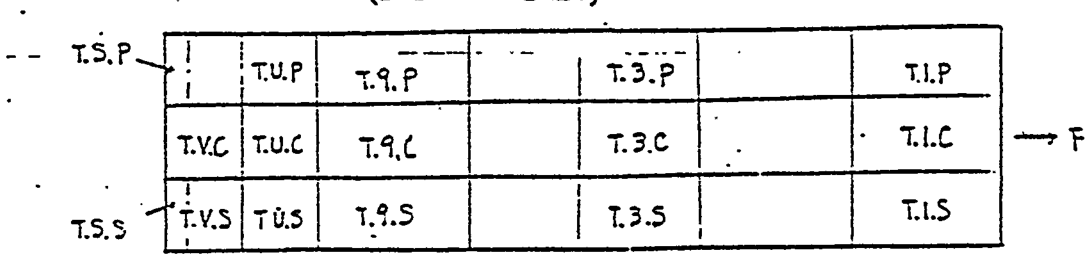
Zone \ Level \ Col. of MLF No.	4 A	5 B	6 C	Remarks	Relevant parts
GRATINGS & UNDER GRATINGS	P	1	P.C.S		D
ABOVE GRATINGS	↓	2	↓		E
RISERS (PIPES)	↓	3	↓		
INSIDE OF ENTRANCE	↓	4	↓		
OUTSIDE OF ENTRANCE	↓	5	↓		
WHOLE ZONE	↓	—	—		
TANK PART OF TANKER	T	1~9 U~Z A , B	P.C.S	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to tank arrangement.	D
SLOP TANK	T	S	↓		

PUMP ROOM



PLAN OF TANK PART

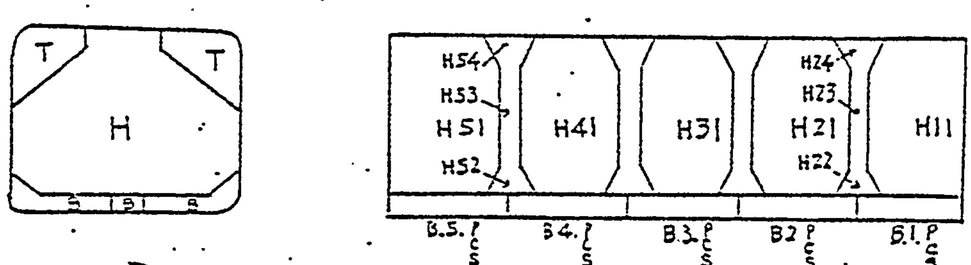
(Parallel Part)



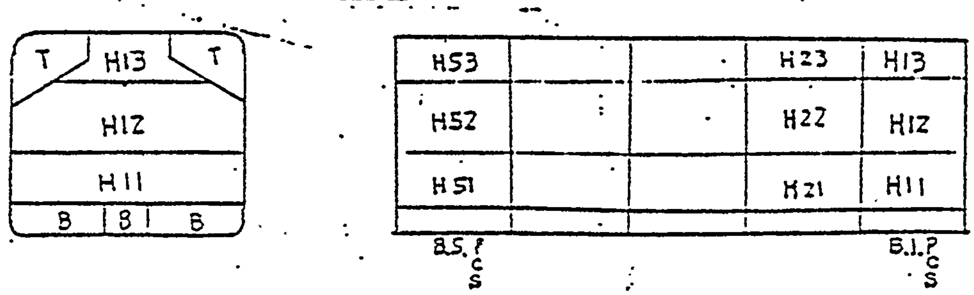
3.9 Parallel part of B/C, O/O, O/B and Cargo Ship

Col. of MLF No. / Level / Zone	4	5	6	Remarks
	A	B	C	
UPPER WING TANK	T	1~9 U~Z A, B	P C S	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft correspon ding to tank arrangement.
SLOP TANK	T	S	↓	
CARGO HOLD	H	1~9 U~Z A, B	1~9	1. Level B: Hold No. from fore to aft 2. Level C: See sketches below
DOUBLE BOTTOM	B	1~9 U~Z A, B	P C S	1. Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to arrangement of tanks and duct keel. 2. C of level C means duct keel.

ZONING OF CARGO HOLD
B/C, O/O, O/B

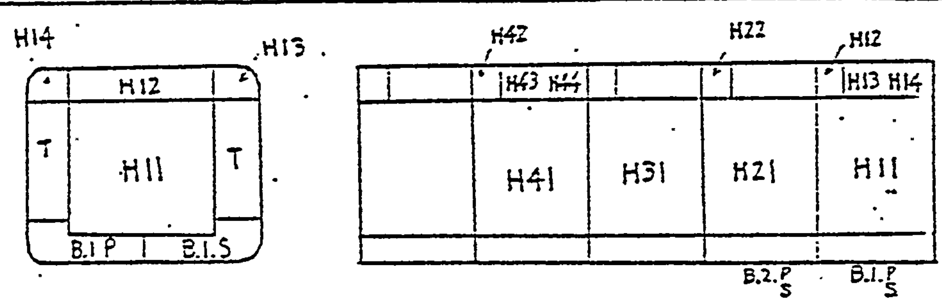


CARGO SHIP



3.10 Parallel Part of Container Ship

Zone \ Col. of MLF No. / Level	4	5	6	Remarks	Relevant parts
	A	B	C		
SIDE TANK	T	1 ~ 9 U ~ Z A , B	P.S.C	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to hold arrangement.	
CARGO (CONTAINER) HOLD	H	1 ~ 9 U ~ Z A , B	1 ~ 4	Level B : Hold No. from fore to aft Level C : See sketches below	
DOUBLE BOTTOM	B	1 ~ 9 U ~ Z A , B	P . S	Level B to be numbered in order of 1-9, U-Z, A, B from fore to aft corresponding to hold arrangement.	



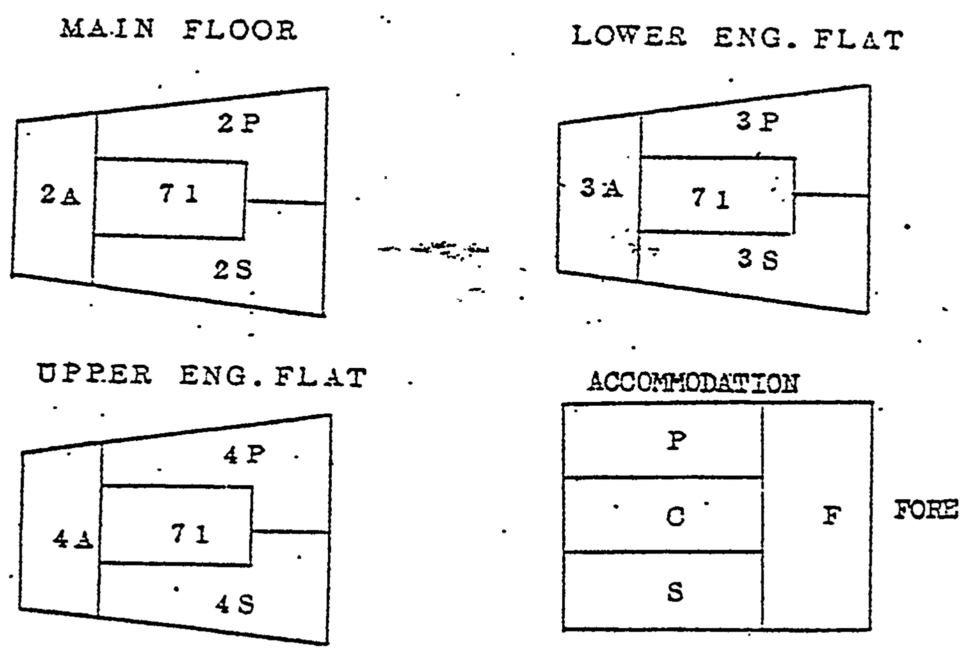
3.11 Overall Zone "Z"

Zone \ Col. of MLF No. / Level	4	5	6	Remarks	Relevant parts
	A	B	C		
OVERALL	Z	Structure symbols	P.S.C -	1. Name plates, canvas, nets, spare parts etc. 2. Level B: Structure symbols to be used if necessary 3. Level C: P.S.C and "-" to be used if necessary	

3.12 Zoning for Electric Outfitting

For electric outfitting, the inside of engine room and accommodation is zoned as follows.

Zone \ Level \ Col. of MLF No.	4 A	5 B	6 C	Remarks
MAIN FLOOR	M	2	P , S A , —	1. Zoning to be as exampl below. 2. "-" means whole flat. 3. Main floor includes it upper and lower sides. 4. Inside of engine casin is not devided down to level C.
LOWER ENG. FLAT	↓	3	↓	
UPPER ENG. FLAT	↓	4	↓	
M/E & ITS VICINITY	↓	7	1	
ENGINE CASING (COMBINED WITH ACC)	↓	5	0	
ENGINE CASING (SPLIT TYPE)	↓	5	3	
1ST. TIER OF ACCOMMODATION	L	1	P, S, C F , —	1. Zoning to be as exampl below. 2. "-" means whole tiers.
~	↓	~	↓	
7TH TIER OF ACCOMMODATION	↓	7	↓	



(All tiers to be zoned like this example.)

CHAPTER IV - ML(F) AND FORM OF MLF-NO. IN IHI

1. Definition of ML(F)

ML(F) is literally Material List for Pallet (Fitting) and one ML(F) corresponds to one pallet. The significance of ML(F) is detailed as follows:

1.1 A ML(F) contains the following information:

1) List of all materials to be prepared and fitted in a pallet with their specifications, weight, quantity, piece number, painting schedule, etc.

2) Job guidance for outfitting work such as "zone" or trade identification.

3) Production control data such as total weight of the, materials in the pallet for resources allocation, stage identification, etc.

4) Outfitting scheduling data such as starting date of the job, etc.

1.2 Coding for each item of information contained in ML(F) is stipulated by respective coding standard of IHI (i.e. piece numbering, staging of outfitting work, zoning, etc.).

1.3 Each ML(F) has MLF-No., meaning respective pallet -No.

This MLF-No. implies stage, trade, schedule and sequence of outfitting work in the pallet, which allows planning, scheciul-ing and controlling of outfitting work by the Production Department, as well as allowing scheduling the issue of draw-ings by the Design Department and controlling or chasing receipt of purchased materials by the warehouse.

1.4. One pallet (MLF) shall be made for one work package.

The quantity of materials in one work package (pallet) shall be decided 'so as to be easily handled or controlled by the available *resources,* but all materials in a pallet zone or for *a* unit must be listed in the ML(F).

2. Breakdown of. Outfitting Work and MLF-No.

In IHI, a ship is divided into four outfitting parts:

1) Hull part other than accommodation
2) Accommodation part
3) Machinery part (main engine room)
4) Electrical part

Further, outfitting for each part is grouped into one of the following five stages:

1) Piece outfitting on-block
2) Unit outfitting on-block (an assembled unit to be installed on block)
3) Machinery unit outfitting both on-block and onboard (a machinery unit = a unit assembled with a machine or machinery such as a pump or motor, etc., and in most cases used in the machinery part);
4) Unit outfitting onboard
5) Piece outfitting onboard

For each ML(F), a MLF-No. is assigned identification to imply such information as type of ML(F), outfitting part, zone, hull block, outfitting stage, trade, or sequence of outfitting work, etc.

A MIF-No. consists of ten (10) columns which are a significant combination of alphabetical letters and numerical numbers implying each item of information mentioned above and as detailed hereunder.

3. Basic Form of MLF-No. (common for all parts)

3.1 Basic Form

1) Outfitting on-block

Col.	1	2	3	4	5	6	7	8	9	10
	T	Part	Block stage	Hull Block Name						Sub-division

2) Unit outfitting on-block

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y	Hull Block Name						Sub-division

3) Machinery unit outfitting on-block and onboard

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y	Machinery No.			-	- (hyphen)	-	Sub-division

4) Unit outfitting onboard

Col.	1	2	3	4	5	6	7	8	9	10
	B	Part	X or Y	Zone Name			Unit Name		-	Sub-division

5) Piece outfitting onboard

Col.	1	2	3	4	5	6	7	8	9	10
	T	Part	Z or K	Zone Name			Pallet Name		-	Sub-division

3.2 Definition by Column of MLF-NO.

1) Column 1 (Type of ML(F))

This column signifies type of the ML(F) as follows:

"T" ...... ML(F) for piece outfitting

"B" ...... ML(F) for unit outfitting

2) Column 2 (Outfitting part)

This column shows the outfitting part where the pallet is installed.

"2" ...... Hull part other than accommodation '-

"3" ...... Accommodation part

"4" ...... Machinery part

"5" ...... Electrical part

3) Column 3 (Outfitting stage)

This column shows the detailed outfitting stage at which the pallet-is outfitted as follows:

(1) Piece outfitting on-block

Hull block stage symbolized by an alphabetical letter at which the pallet is to be outfitted. Symbols Of stages are given by another standard.

Example:

"S" ...... Sub-assembly stage

"A" ...... Assembly stage

"B" ...... Back-assembly stage (turned over)

(2) Unit outfitting on-block

"X" signifies a unit which is installed on-block without being assembled into a large unit.

"Y" means a large unit to be installed on-block which consists of one *or more* units of "X" level anti/or other materials.

(3) Machinery unit outfitting

"X": A unit which is installed on-block or directly onboard without being assembled into a large unit.

"X": A large unit to be installed on-block or directly onboard which consists of one or mo units of "X" level and/or other materials.

(4) Unit outfitting onboard

"X": A unit to be installed onboard without being assembled into a large unit.

"Y": A large unit to be installed onboard which consists of **one** or more units of "X" level and/or other materials.

(5) Piece outfitting. onboard

"X" : Work stage standard (general)

"Y": Accommodation oufitting atgrand block stage before erection (pre-erection stage) and machinery outfitting"srage *for* grand engine casing block before erection..

4) Columns 4 - 9

These columns signify the hull block, machinery number representing the unit or zone in a ship as follows:

(1) piece outfitting on-block-

Name of the hull block on which the pallet is outfitted. " Naming of hull block is stipulated by other standard..

(2) Unit outfitting on-block

Same as(l) above.

(3) Machinery unit outfitting on-block and onboard

Columns 4 - 6: Machinery number which represents the unit. Numbering of machinery is given by other standard.

columns.7 - 9: Hyphen (fixed).

Note: To be applied to, in most cases, machinery part.

(4) Unit outfitting onboard

Columns 4-6: Name of zone where the pallet is outfitted.

Zoning is to be referred to other standard (Chapter VII).

Columns 7 - 8: Name of the unit.
Detailed naming is given by the respective MLF-coding guidance for each part.

column 9 : Hyphen (fixed)

(5) Piece outfitting onboard

columns 4 - 6: Name of zone where the pallet is outfitted.

columns 7 - 8: Name of the pallet..

Column 7 . . . Trade of the work based on kinds of fittings.

Column 8 . . . . Sub-trade or sequence of the work.

Detailed naming is given by the respective MLF-coding guidance for each part.

Column 9 : Hyphen (fixed)

5) Column 10 (Sub-divsion)

Usually, palletization is so determined as to compile all outfitting materials for one assembly block, zone in the ship or *a unit* into one pallet, and the pallet number, or MLF-No., is allocated at the planning stage of ship construction when complete composite drawings for outfitting or palletization are not available, and it could happen

that materials in a certain pallet zone or unit are too numerous to be compiled in the allocated pallet in terms of resources available or fitting weight when the design progresses further. In such cases, the pallet is sub-divided further by giving a sequential number or significant alphabetical letter in column 10 for identification.

Column.10 is also used for identification of detailed assembly stage or a group of fittings in tune electrical part.

Details of sub-division are given respectively for each part by the guidance of MLF-No.

CHAPTER V- CODING GUIDANCE OF MLF NO. (MACHINERY PART)

As an example of MLF-coding outlined in the praceding chapter, coding guidance for MLF-No. for machinery part is introduced herein.

1. Piece Outfitting On-block

Example:

1	2	3	4	5	6	7	8	9	10
T	4	A	2	D	3	1	P	-	0
Type	Part	Block Stage	Block Name						Sub-division

Col	Item	Symbal.	Description
1	Type of MLF	T	Fixed
2	part	4	Fixed
3	Block Stage		Symbols defined by other standard to be used
		S	Sub-assembly
		T	Sub-assembly (turned over)
		M*	Middle-assembly
		N	-Do- (turned over)
		H	Assembly without shell plate (crate)
		A*	Assembly (block assembly before erection)
		B*	Back assembly (turned over)
		G	Grand assembly (pre-erection)
Note: Usually, outfitting is done at *-marked stages.			
4-9	Block Name	Alpha & Numeric	Block name decided by hull part to be used. The columns are to be filled from column 4, and rest of columns, if any, are to be filled with a hyphen.
10	Sub-division	0 - 9	Guidance for sub-division guidance of Article 6 is to be referred to.

2. Unit outfitting On-block,

Example: 1 2 3. 4 5 6 7 8 9 10

Col	Item	symbol	Description
1	Type,	B	
2	Part		
3	Unit Stage	X or Y	Refer to 3..2.3 (2) of Chapter IV.
4-9	Block Name	Alpha & Numeric	Same as columns 4-9 of 1 above. Piece outfitting on-block.
10	Sub-division	Block Stage symbol	To be sub-divided by block stage.

Note: In case two or more units are installed on one block, assembly sign (A, B, C . . . . or 1, 2, 3 . . . .) shall be put in the corresponding column of ML(F) for identification in consideration of sequence of installation.

3. Machinery- Unit Outfitting.

Example:

1	2	3	4	5	6	7	8	9	10
B	4	X	1	9	8	-	-	-	0
Type	Part	Unit Stage	Mach. No.			Hyphen			Sub-division

Col	*Item*	Symbol	Description
1	Type c	B	Fixed
2	Part	4	Fixed
3	Unit Stage	x or Y	Refer to 3.2.3 (3) of Chapter IV.
4-6	Machinery NO.	Numeric	Machinery No. is given by other Standard.
7-9	Hyphen		Fixed
10	sub-division	0 - 9	Sequential; sub-division guidance of Article 6 is to be referred to.

4. Unit Outfitting Onboard

Example: 1 2 3 4 5 6 7 8 9 10

B	4	X	M	1	1	0	1	-	0
Type	Part	Unit Stage	Zone			Unit Number		Hy-phen	Sub-divi-sion

Col	I tern	symbol	Description
1	Type	B	Fixed
2	Part	4	Fixed
3	Unit Stage	X or Y	Refer to 3.2.3 (4) of Chapter IV.
4	Zone	M	Machinery space
		A .	Steering gear room
5-6	Zone No..	Numeric	Zone numbering is given by other standard.
7-8	Unit Number	01-49	Unit with pipes
		50-69	Unit witkout pipes
		70-89	Unit with small pipes (for control air piping etc.)
9	Hyphen		Fixed
10	Sub-division	0 - 9	Sequential; Subdivision guidance of Article 6 is to be referred to.

5. Piece Outfitting Onboard

Example:

1	2	3	4	5	6	7	8	9	10
T	4	Z	M	1	1	P	-	-	2
Type	Part	Stage	Zone			Pallet Name		Hy-phen	Sub-divi-sion

Col	Item	Symbol	Description
1	Type	T	Fixed
2	Part	4	Fixed
3	Stage	Z	Onboard stage (General
		K	Outfitting stage on grand block (Engine casing outfitting and joiner fitting in the engine control room)
4	Zone	M	Machinery room
		A	Steering gear room
5-6	Zone No.	Numeric	Zone numbering is given by other standard.
7-8	Pallet Name	Alpha	By combination of columns 7 and 8 pallet name is difined as detailed below
9	Hyphen	-	Fixed
10	Sub-division	0 - 9	Sequential; Subdivision guidance of Article 7 is to be referred to.

Pallet Name

COl.7	COl.8	Description (Trade & Fitting)
P		Piping (including miscellaneous tanks)
P	A	Piping at "Blue sky" *stage**
P	-	Other pipings
		* "Blue sky".stage is the stage immediately after erection of a certain block at which the overhead block is not yet erected and the zone is opened to the atmosphere.
C		Control and automation system
C	A	Fitting or units at "Blue Sky" stage
C		Fittings
K		Traffic system
K	A	Traffic fittings at "Blue sky" stage
K		Other traffic fittings
G		Machining and adjusting
G	A	Auxiliary machinery at "Blue sky" stage
G	S	Sea chests
G	R	Handle lock for valves
G	W	Wiring system
G	D	Damper controllers
G	E	Remote-operated closing devices
G	B	Pipe-bonding strips

COl.7	Col. 8	Description (Trade & Fitting)
G	v	Distance pieces (pipes) for ship side valves
G	T	Tank fittings
G	H	Extension spindles for valves
G	L	Liners for auxiliary machinery
G	Z	Others
I		Insulation
I	E	Funnel
I	M	Main exhaust pipes
I	S	Ventilation trunks
I	u	Upper deck
I	P	Pipings
I	T	Tanks
T		Steelwork (ventilation trunks)
T	A	VentilatiÒn trunks at “Blue sky” stage
T		Other ventilation trunks
F		Steelwork (foundation seats)
F	A	General foundation seats at “Blue sky” stage, seat units and spare parts units
F	x	Seats for spare parts .
F		Other seats .
u		Steelwork (funnel. part)
u	E	Stack (uptake for boilers)
u	S	Supply air duct for boiler (or M/E)
u	H	Main engine exhaust gas pipe

C0l.7	Col. 8	Description (Trade & Fitting)
X		Spare parts, accessories
X	A	Spare parts and accessories at “B1ue sky” stage
X		Other spare parts and accessories
E		Main engine
E	D	Diesel main engine
E	H	High pressure turbine
E	L	Low pressure turbine
E	R	Reduction gear
E	T	*Thrust* bearing
E	C	Main condenser
B		B o i l e r
B	B	Boiler
B	H	Gas air heater
B	C	A.C.C. (Auto-Combustion Control)
B	S	Soot blower
B	F .	F.W.C. (Fresh Water Cooler)
B	G	Gauge panel
B	I	Smoke indicator
B	N	Burner-and related parts
B	E	Exhaust gas economizer
B	L	Double evaporation boiler
B	D	Separator drum

Col.7	col.8	Description (Trade & Fitting)
A		Auxiliary machinery"
A.	T	T/G (Turbo-Generator)
A	D	D/G (Diesel Generator)
A	C	C.O.P.T. & B.W.P.T. (Cargo Oil Pump Turbine & Ballast Water Pump Turbine) .
A	E	Emergency generator
A	F	Emergency fire pump
A	S	Steering gear
A	R	Rudder
J		Propeller-shaft
J	S	Spare propeller shaft
J	P	Propeller, propeller fastening devices
J	I	Intermediate shaft
J	T	Propeller shaft
J	B	Intermediate shaft bearing. (including thrust bearing, aftmost bearing, overhang bearing)
J	E	sealings and washers
J	D	Stern bearing (tube), lignum vitae, cutless bearing
J	R	Revolution meter and shaft grounding device
J	Y	Spare propeller
J	J	Bulkhead stuffings

C01.7	C01.8	Description (Trade & Fitting)
Z		Miscellaneous .
Z	N	Marking tapes, name plates for valves, caution plates
Z	T	Thermometers and their cases
Z	H	Skylights, hatches
Z	C	Covers for fly-wheel and couplings
Z	B	Stowage boxes for chain blocks
Z	D	Doors (except for shaft tunnel), wire nets
Z	E	Eye plates
Z	M	Bolts & gaskets for manholes
D		Joiner work in engine control room and workshop
D	T	Fitting pieces for joiner
D	M	Joiner fittings
D	X	Furnitures
D	D	Deck covering
D	I	Insulation
	Z	Fitting (welding) of materials temporarily installed at preceding stages (pallet for fitting work and not for preparation of materials)

6. Guidance for Sub-division of a Pallet on Piece Outfitting On-block and Unit Outfitting

6.1 General

a) No sub-division is applied to *a* pallet of machiner], steel fittings (gratings; handrails, etc.) and pipe fittings (valves, filters, etc.).

b) A pallet for pipes may be so sub-divided as to group about 30 pieces of pipe in each sub-division.

c) When the joiner fitting in the engine control room and workshop is carried out on-block (grand block) the ML(F) shall be numbered according to the numbering system for piece outfitting onboard. In Such a Case, COlumn 3 Of MLF-No. shall be "K" and sub-division shall be made same es piece outfitting onboard.

d) Outfitting of steering gear by unit is made as detailed herein.

6.2 Sub-division Guidance (Except Steering Gear Unit)

Col. 10	Description
0	a) Auxiliary machinery, valves, joint pieces, eye plates (except. stock materials). *Spectacle flanges, =pansion joints, special gaskets* & bolts, foundation seats for auxiliary machinery, supports for gratings and floor plates, pipe bands (excludidng stocked ones), penetration pieces, manholes, scupper washer, grids for seachests, coatings (excluding stocked ones), tanks, window sashs of control room, remote-operated closing devices, doors, ventilation trunks, air passages in funnel, gratings, ladders, vibration, absorbers, spring hangers, trolleys, zinc plates in seachests. b) All fittings installed at block stage "H" by hull *construction dept. such* as bottom plugs, safety gratings for holes, eye plates for lifting propeller. c) pipes
1 - 7	Pipes
8	Insulation materials
9	Spare number

6.3 Sub-division Guidance for Steering Gear Unit

Col. 10	Description
1	Tiller, carrier key, tiller key
2	Weld liners
3	Common bed, chock liners, foundation bolts, side stoppers
4	Steering gear, accessories
5	Rudder carrier, foundation bolts, side stopper, be
6	Electric parts

7. Guidance for Subdivision' for Piece Outfitting Onboard

7.1 Piping....."P"

1) General

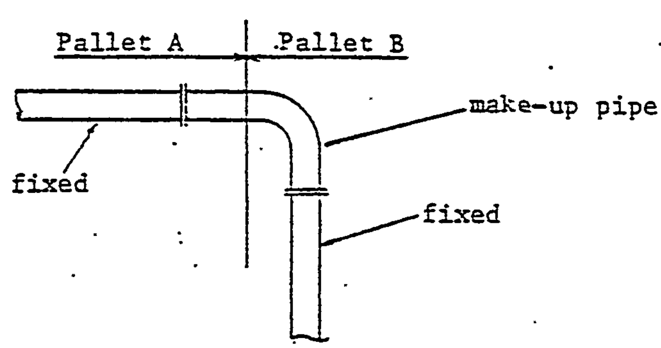
(1) subdivision shall be made in order of fitting work of each material.

(2) Workload shall be leveled appropriately for one pallet.

(3) Number.of pipes in one pallet shall be about-30 excluding make-up pipes, but pallet weight shall include all pipes.

(4) Pipe fitting pieces such as supports, bands, boks, etc., shall be included in the pallet of corresponding pipes.

(5) Make-up pipes (short pipes to connect the corre-spending pipes (of same system) of two adjacent pallets, and dimensions of which are decided after installation of the two pallets), shall be included in eithex one of the pallets.



(6) Materials to be included in the pallet as the "blue sky" stage shall be those with weights over 30 kg each and suitable for "blue sky" fitting. some materials with weight less than 30 kg may be installed at the "blue sky" stage, if convenience.

(7) Some materials to be installed at *the* "blue sky" stage in a certain zone whose installation date is different from others, may be grouped separately by applying subdivision.

(8) Spring hangers, vibration absorbers (including fitting stands and seats) shall be grouped into subdivision 9.

(9) L. O. piping for the stern tube shall be insta1led.ed at the "blue sky" *stage*.

2) Subdivision guidance

Col. 7.8	Col. 10	Description	Remarks
PA	0	No subdivision (one pallet)	Detailed materials
	l - 9	Sequential for two or *more* pallets	to be same as "*p*-"
P-	0	No subdivision with pipes less than 30 pieces	
	1 - 8	Sequential; pipes, valves, joint pieces, expansion joints, rose boxes, pipe bands, blind flanges, small *tanks*, L.O. pipes for sealing of stern tube, sounding head valve, saw dust supplier.	
	9	Spring hanger, vibration absorber	

7.2 Control and Automation System . . . . . "C"

Col. 7.8	Col. 10	Description	Remarks
CA	0	No division	* A pallet is to made for each flat
	1 - 9	Sequential	
C-	1	Control & automation equipment & foundation seats; gauge panels (with fitting pieces), gauges, transmitters, limit switches, controllers, pressure Switches, manometers, air purge unit, **solenoid valve panels,** seats for panels, meters and their seats, pressure control system for L. O. for stern tube.	
	-2	Pipes and pipe fittings; . *pipes* (10 mm in dia. or less), pipe joints, **valves (10ϕ or less),** pressure reducing valves, 3-way valves, pipe guards, special flanges, plugs, gaskets, pipe bands, gauge packings, supports for multiple pipes, supports for vinyl pipes, oil sprayer, seal pot, etc.	
	3	Multiple pipes and theL terminals.	
	4	**Vinyl pipes for CO2** analyzer	

7.3 Traffic System ...... "K"

1) General

(1) Subdivision shall be made as to group materials of similar function in order of installation sequence.

(2) Materials to be. installed at "blue sky'' "stage shall be those that are installed before assembled unit(s) .

(3) combinations of "-2" and "-3", "-4" and "-5', "-6" and "-7" show the materials to-be installed together.

(4) Material, installation of which is started very late in one zone, shall be grouped into "-9."

2) Subdivision Guidance

Col. 7.8	Col. 10	Description	Remarks
KA	0	Materials to be installed before assembled unit(s)	
K	1	Stanchions, hand rails, round bars, stays, end pieces, flat bars for coaming around the gratings.	• Number of gra ings in one pallet shall 10 in princip If no problem all gratings one zone may grouped in o pallet. • Materials of "-2" shall correspond t ones of "-3."
	2	Grating supports, furrings	To be instal together
	3	Gratings, floor plates, inclined ladders, vertical ladders, steps, manholes, pillars for floor plate	
	4	Same as 2	-Do-
	5	Same as 3	
	6	Same as 2	-Do-
	7	Same as 3	
	9	Materials to be installed late	

7.4 Machining and Adjusting ...... "G"

1) General

(1) Materials to be installed at "blue sky" stage shall be subdivided into the following two pallets in order of installation sequence, if necessary.

a) Materials to be installed immediately after erection of the deck or flat.

(b) Materials to be installed after installation of foundation seats or similars at prior stages and before installation of assembled units or erection of overhead blocks.

(2) Materials to be installed at other than "blue sky" stage, shall be grouped by their functions.

(3) One pallet shall be made per flat or deck, in principle. However, only one or two pallets may be enough for a whole ship in the case of a certain material, as remarked herein.

2) Subdivision Guidance

Col 7.8	Col. 10	Description	Remarks
GA	0	No sub-division	
	1	See 1), (1) "a) above."	
	2	See 1), (1) b). above.	
		. Materials to be included in O - 2 are: overboard penetration pieces and brackets, shipside (sea water suction or overboard discharge) valves with Packing bolts, washer for echo sounder (including log sonar), bilge hat cover, incinerator, seats for fan motors and stuffing boxes for pump room, watertight doors of shaft tunnel, main L. O. pump and guide, machining tools (universal machining tool, lathe, boring machine, grinder, eletric Saw, hose reel, gas welder, electric welder), fittings in control room, CO2 meter, sampler, cooler, basin, water fountain, toilet unit, wash basin, unit cooler, COP local control panel, FWC control box, local gauge board for M/B, local gauge board for boiler, sterilizer, chemical cleaning device for heat exchanger, boiler fan, hychrorator, aux. condenser, calorifier, ref. machine, air-tank, compressor, emergency fire Pump, air tank and compressor for emergency fire pump, air tank for emergency shut-Off valve, sampling cooler with piping for control, hydrofore tank for drinking water.	

Col. 7.8	Col. 10	Description	Remarks
GS	0	Fittings for seachests and cathodic protection (seachest grids, zones & bolts).	To be grouped into 3 pallets for respective 3 zones M1F, M1M, and M1A per ship, in principle.
GR	0	Hadle lock for valves	1 pallet/ship, in principle.
GW	0	Wiring system (steel wire & wiring fittings)	-Do-
GD	0	Damper controller	-Do-
GE	0	Remote operation devices for emergency valves and doors, etc.	"
GB	0	Pipe bonding strips	"
GV	0	Sea water suction and overboard discharge valves, bolts & nuts, distance pipe pieces	To be palletized by zones (M1F, M1M, M1A) and flow direction (suction, discharge)... Total 6 pallets/ship, in principle.
GT	0	Tank fittings, level gauge, level indicator (scale), float switches, thermometer bosses, cocks with lock.	1 pallet/flat, in principle
GF	0	Emergency fuel oil stopping device	

Col. 7.8	Col. 10	Description	Remarks
GH	0	Extension spindles for valves	1 pallet/s in princip
GL	0	Liners, bolts & nuts for aux. machinery	
GZ	0	Miscellaneous; Sight window of pump room, trolley stopper, etc.	

7.5 Ventilation Trunk ...... "T"

In principle, subdivision by Col. 10 is not applied unless specially required. If required, subdivision shall be numbered in order of outfitting sequence.

Col. 7.8	Col. 10	Description	Remarks
TA	0	Unit or materials to be installed before erection of the block ("Blue sky" stage)	
T-	1 ~ 8	Main trunks, branch trunks, ventilation fans & foundation seats, expansion trunks, supports, bolts & nuts, gaskets, terminal trunk*	* Terminal trunk shall be put into the last pallet.
	9*	Materials whose installation is very late (damper handle, etc.).	* "-9": 1 pallet/ship

7.6 Foundation Seat . . . . . . "F"

Col. 7.8	Col. 10	Description	Remarks
FA	0	No subdivision	Material to be installed at "Blue sky" stage shall be those that are fitted or temporarily fitted before installation of a unit or erection of the block.
	1	Seats for aux.machinery and tanks, foam coaming, pipe	
	9	Coamings, deck coaming, submaterials for aux. machinery seats, units	
F-	0	No subdivision	Pipe coamings and deck coamiags teeated as stock material are not palletized at this stage.
	1	Seats for aux. machinery and tanks, foam coamings, pipe	
	8	coatings, deck coamings, submaterials for aux machinery seats, etc.	
	9	Materials whose installation is. very late.	
Fx	1	Seats for spare parts fitted on the hull shell (to be installed before units).	To be installed at "Blue sky" Stage.
	2 .	Seats for spare parts fitted on units (to be installed after units)	
	3	Seats whose installation is very late (hook for handle rotator, etc.)	

7.7 Funnel Part. . . "U"

Col. 7.8	Col. 10	Description	Remarks
UA	O	No sub-division	Materials installed at "Blue sky" stage shall be assembled into large unit before installation
	1 ∫ 9	Sequential numer	
UE US UH	1	Stack (uptake), supply air duct; main engine, exhaust gas pipes, expansion jointe, bolts & gaskets for flange, ladders (inside) sleeves, supports with bolts	
	2	Streight uptake & upper funnel, spring hangers, blind plates for branch pipes near the outlet of inert gas, angle supports of , insulation material.	

7:8 Insulation . . . . . "I"

No sub-division is applied in principle.

7.9 Spare parts, Accessories .... "X"

Col. 7.8	Col. 10	Description	Remarks
XA	O	No sub-divisiOn	"Blue sky" stage
	1	Materials to be installed immedi-ately after installation of a block or on unit	
	2	Materials to be installed after installation of foundation seats for them.	
X-	1.	General spare parts and accessories	
	2	Small spare parts storable in the steel cabinet.	

7.10 Main Engine . . . . "E"

COl. 7.8	Col. 10	Description	Remarks
ED	1	Main bodies	
EH			
EL	2	Installation liners (welded)	
ER			
ET			
EC	3	Installation liners (chock), bolts, M/E,side stoppers	
	4	Fittings Pipes, valves, orifices, bolts	
	5	*Fittings* Gauge for installation, jigs for shaft alignment, sests for jacking Up test for 2nd wheel, F.O. handles	
	6	L. O. *discharge* Pipes for the crank case (lower)	
	7	-Ditro (Upper)	
	8	Materials to be used just before the *trial of* M/E such as sight glass to bubbler pipes, water level gauge, float switch, etc.	
	9	Miscellaneous	

7.11 Boiler . . . . "B"

Col. 7.8	col.10	Description	Remarks
BB	1	Main bodies	
BH			
BC	2	Installation liners, bolts, seats	
BS			
BF	3	Fittings (vendor's supply)	
BG			
BI	4	Fittings (other than vendor's supply)	
BH			
BL	9	Miscellaneous	
BE			
3D			

7.12 Auxiliary Machinery . . . . "A"

Sub-division shall be made so as to *group materials by their* functions. Sub-division is not applied to steering gear rudder plate, in principle.

Col 7.8	col. 10	Description	Remarks
AT	1	Main bodies	
AD			
AC	2	Installation liners (welded)"	
AE			
AF	3	Instllation liners (Chock)	
	4	Fittings	
	9	Miscell meous	
As	0	Bush bolder or lignite bush, bush stopper	
AR	0	Rudder stock, rudder plates, coupliag bolts, (With Stoppers), pintle [illegible] for cement, cement, rudder cover	

7.13 Propeller Shaft .... "J"

Col. 7.8	Col. 10	Description	Remarks
JS, JP, JT, JB, JE, JD, JR, JY, JJ	1	Main bodies (JP includes propeller fastening devices, propeller nut and CPP)	
	2	Installation liners (welded)	
	3	Installation chock liners and bolts	
	4	Fittings (vendor's supply)	
	5	Fittings (other than vendor's supply) JP .... stuffings JD .... lignum vitae, cutless bearing, etc.	
	6	Coupling bolts	
	9	Miscellaneous JP .... anti-corrosive zinc, etc.	
JI	1 ~ 8	Sequential by each intermediate shaft (in case of two or more int. shafts)	
	9	Joint bolts & nuts	

7.14 Miscellaneous .... "Z"

Sub-division shall not be made (i.e., one pallet per ship) except for ZT (two pallets per ship), in principle.

Col. 7.8	Col. 10	Description	Remarks
ZN	0	Marking tapes, nameplates for valves, caution plates	1 pallet/ship
ZT	1 2	Thermometers & cases (for stern tube) -Do- (others)	2 pallets/ship
ZH	0	Skylights, hatches	1 pallet/ship
ZC	0	Flywheel cover, coupling cover	"
ZB	0	Stowage boxes for chain blocks	"
ZD	0	Doors (except for shaft tunnel),	"
ZE	0	Eye plates (specially ordered)	" Eye plates treated as stock material not to be listed in MLF.

7.15 Joiner Work in Engine Control Room and Work Shop .... "D"

Col. 7.8	Col. 10	Description	Remarks
DT	1	Fitting pieces	
	2	Coamings	
	3	Fitting pieces for ceilings	
	4	Steel joist	
	5	Window sash	
DD	1	Cement	
	2	Titles	
DM	1	Base ceilings of walls	
	2	Base ceilings of ceiling	
	3	Finish linings of walls	
	4	Finish linings of ceiling	
	5	Entrance doors	
	6	Windows	
DI	1	Heat insulation of walls	
	2	Heat insulation of ceilings	
DX	1	Furniture	

7.16 "-" Fitting (welding) of materials temporarily installed at preceding stages.

This-pallet is for fitting work and does not include physical materials. MLF for this pallet is automatically made by the computer based on the key sign for temporary installation at preceding *stages.* For each designated zone, the pallet with MLF-NO. could be made, but normally, one pallet per flat or deck is made and subdivision by Col. 10 is not applied.

Col. 7.8	Col. 10	Description	Remarks
-Z	0	Fitting of temporarily installed materials at preceding stages.	

CHAPTER VI - AN INTRODUCTORY EXAMPLE OF PALLETIZATION ON NASSCO'S DRAWINGS

1. Introduction

In May, 1979, we (IHI Engineers)" visited NASSCO to make a basic survey on outfitting system currently applied at NASSCO and had discussions and meetings with relevant people from Design *Engineers* to Field Supervisors.

Through discussions with Design Engineers we learned that NASSCO had already utilized composite drawings for some congested outfitting compartments like engine *room* for development of working drawings though the composite drawings were used only for clearance of interference between different systems such as steam piping system and cooling sea water piping system;

We brought back *to* Japan some of the composite drawings of the machinery space of San Diego class 185,000 DWT oil tanker and tried *to make* an example of palletization (pallet list and MLF) based on them to give concrete idea of palletization.

Based on IHI standards and some assumptions our design engineers made a partial and tentative palletization as introduced herein.

The attached copies of NASSCO's drawings are the result of the tentative palletization and to be referred to concurrently with the-description of this chapter.

As we did not get all the details about hull structure or machinery arrangement of the engine room; there might be some misunderstandings of the drawings by our design engineers. So, it is recommended that NASSCO shall complete the palletization on these drawings correcting misunderstandings, if any, by themselves in the same manner introduced by this example.

2. Assumption

As described in the preceding chapters, palletization is made by stage, zone and trade in principle. In other words, block segregation, zoning and partition of outfitting pares except details etc. should be decided before starting of composite drawings and pallet-making.

For introduction of an example of palletization on NASSCO'S drawings,we applied some assumption concerning block arrangement and zoning as follows:

2.1. Block Arrangement

As we are not *familiar* with NASSCO'S way of block segregation, we assumed the hull block arrangement as shown in Fig. 6-1. In Fig. 6-1, pallet names at on block stage are also given. BLock name is given in the parentheses and pallet name under respective number in circle.

IHI has a standard for block naming and the block name in Fig. 6-1 was decided according to this standard.

For example,

DB 1 P

Portside

First from fore

Double bottom

LS 2 S

Starboard side

Second from fore

Lower shell

2.2 Zoning

Zoning is assumed as Fig. 6-2. The number given for each compartment in Fig. 6-2 defines Level B and C of the *zone* symbol as described in Chapter III. This example is for. the machinery space and the initial letter for Level A. "shall be "M". Namely, zone name in full will be;

MLL, M12, M22, M23 . . . . etc.

Allm materials to be outfitted onboard are palletized based on this zoning and the zone name (= zone symbol) is used as a part of MLF-No. (See Chapter IV, V)

2.3 Staging

Three stages are applied to this tentative palletization on the ground that pre-erection outfitting is applied. The three stages are;

on-block stage (Blue)

Unit stage . (Green)

Onboard stage (Pink)

At first we studied at what stage each material should be installed and what materials could be grouped into units (machinery unit, piping units etc.) in consideration of convenience of outfitting work, sequence of installation", block arrangement and zone. And then we grouped materials into pallets by block, unit and zone.

In the attached NASSCO's drawings, material to be outfitte it on-block stage are identified by blue color, *unit* sta by green color and onboard stage by pink co1or.

2.4 Machinery Name

In-NASSC0'S drawings we brought back, -no system or machinery name is given though the system number like 209-03 or 514-09 is provided for each system. We guessed the system and machinery names from *the* drawings for identiZica- tion of pallet as written in the drawings.

FIG. 6-1 ARRANGEMENT OF HULL BLOCK AND PALLET ON BLOCK

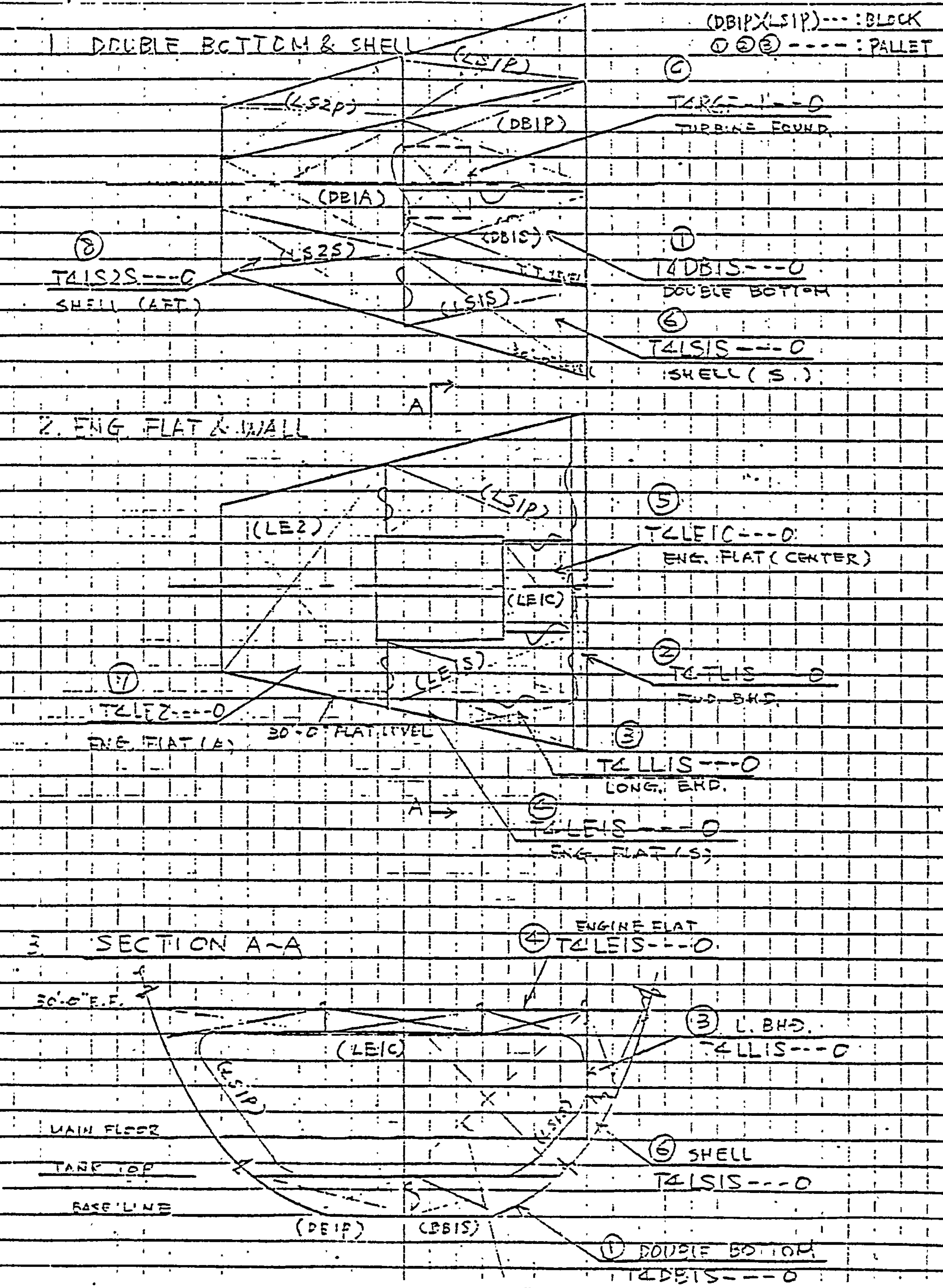
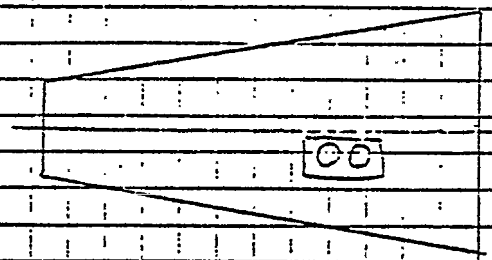
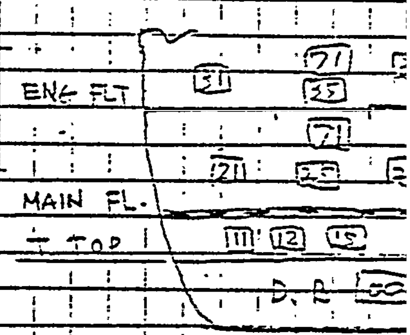


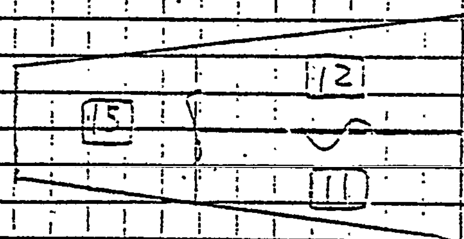
Fig. 6-2 ZONING OF ENGINE ROOM

DOUBLE BOTTOM





MAIN FLOOR (UNDER)



MAIN FLOOR (UPPER)

ZONE SYMBOL

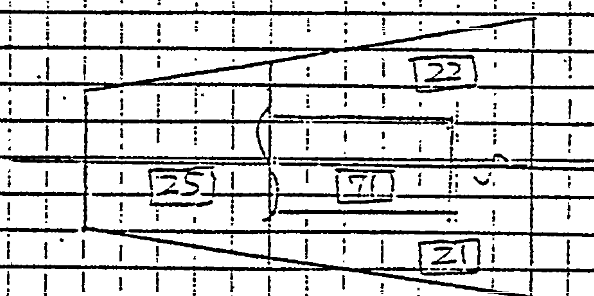
M 1 1

Level

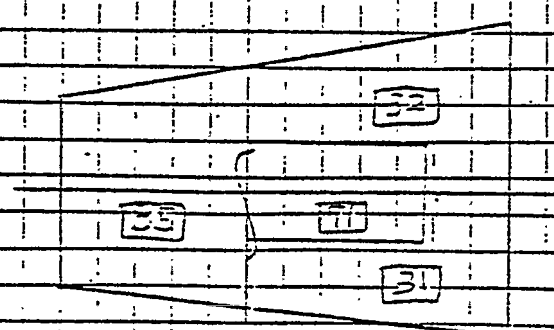
Level B

Level A

(See Chapter I



ENG FLAT



3. Pallet List

Sample pallets are listed *in* the pallet list of Fig. 6-3. MLF-No. is coded in accordance with the coding guidance introduced in Chapter V with excepcion for on-block *stage.* In the Pallet list of Fig. 6-3, MLF-No. of on-block pallets is coded as

	Col 1	2	3	4	5	6	7	8	9	10
	T	4	D	B	1	s	-	-	-	0
or	T	4	T	L	1	s	-	-	-	0

I

I Block *name*

As may be noticed, the substage of hull block assembly such as "A. ..Assembly" or "B . ..Back assembly" which is to be identified by column 3 according *to* the guidance of Chapter V is omitted here. This is only for this example and *in* "actual palletizing " the substage must be clearly given.

There are many pallets as shown in the drawings, but all pallets are not listed in the. pallet list of Fig. 6-3. "It is recommended for NASSCO to complete grouping the remaining materials into pallets and make pallet list as a practice.

MLF. NO. 管理表

6-3 (1/2) MLF. NO. 出図依頼表

PALETTE LIST (1/2)

ステージ MLF-No	搭載日	取付図番	管（継線）	取付重量	作業開始日	所要日予定表 (A.出図予定 B.出図日 C.搭載日 D.MLF投入日)
		1	DOUBLE BOTTOM (FS)			ON-BLOCK STAGE
		2	FWD. BHD. (S)			ON-BLOCK STAGE
		3	LONG. BHD. (LS)			ON-BLOCK STAGE
		4	30'-0" ENG. FLAT (S)			ON-BLOCK STAGE
		5	↓ ↓ ↓ (C)			ON-BLOCK STAGE
		6	SHELL (LSF)			ON-BLOCK STAGE
		7	30'-0" ENG. FLAT (A)			ON-BLOCK STAGE
		8	SHELL (LSA)			ON-BLOCK STAGE
		9	RED. GEAR FOUNDATION			ON-BLOCK STAGE

Corresponds to circled No. in the drawings

Fig. 6-3 (2/2)

MLF. NO. 管理表

MLF. NO. 出図依頼表

PALETTE LIST (2/2)

MLF. NO.	次ステージ MLF−No	搭載日	取付図番	管(電線) / 取付重量	作業開始日	所要日予定表 (A.出図予定 B.出図日 C.搭載日 D.MLF投入日)
B1X103---0	T1DB1S---0		10	AUX. CIRC. W. PUMP UNIT		UNIT STAGE
B1X110---0	T1DB1S---0		11	S. W. PUMP UNIT		
B1X11101-0	T1DB1S---0		12	PIPE UNIT		
B1X115---0	T1DB1S---0		13	DRAIN TANK & PUMP UNIT		
B1X12101-0	T1LE1C---0		14	CARGO T. STM. PIPE UNIT		
B1X121---0	T1LS1S---0		15	L.O. COOLER UNIT		
B1X152---0	T1DP1P---0		16	CONDENSATE PUMP UNIT		
142M11P--0			21	ERECTION PIPE (FR)		ON-BOARD STAGE
142M15P--0			22	(A)		
142M11P--0			23	(MAIN ENG.)		

PAGE 175

4. MLF (Material List for Pallet)

For a typical pallet at each stage, we tide a MLF assuming major information like piece number or weight of material etc. as shown in Fig. 6-4: *Minor* information to be contained in actual MLF are omitted here for simplification.

As for explanation for each column, the Article 2.4 of Chapter II should be referred to.

4.1 On-Block Stage

Fig. 6-4 (1/5) shows the MLF for (9) piping pallet "T4RGF-2-0 on-block taken up as an example. This pallet is install on the hull block "RGF-1" at pre-erection stage. All mate- *rials to* be outfitted on "RGF-l" at pre-erection stage including pipe supports, gaskets *or* bolts and nuts should be grouped into this pallet as listed in Fig. 6-4 (1/5). All materials are prepared by this pallet and delivered to the block site to be outfitted at appropriate stage of block assembly, and proceeded to the next stage with the block.

In general, materials to be fitted at on-block stage sha be;

Pieces directly fitted to hull structure such as manholes, penetration pieces, corrosion protection zinc etc.

pipes, ventilation ducts or electric cable trays which are laid right above or beneath the decks and flats, or near the bulkheads and steel walls.

Fittings directly welded to the hull structure in the cargo hold such *as* vertical ladders, steps, sounding pipes of **tanks;** foundation seats for deck machinery etc.

Pipes, valves, suction mouths or any *other* fittings located in the enclosed spaces workability in which at later stage-is very bad such *as* double bottom or deep tanks.

In making on-block pallet, size and segregation of z pallet, location of pipe joints and time of installation etc. are *to be so* decided as not to disturb hull construction work badly ,or in consideration of subsequent outfitting work and facilities availability. For example, a pipe must not overhang a block nor be located at a place which requires very careful positioning of adjacent *or* upper hull blocks at erection to avoid damage. And position of pipe joints should be decided to minimize the number of make-up pipes. <u>The best efficiency of shipbuilding in total span including both hull construction and outfitting must always </u>be in <u>mind for Planning of Palletization</u>.

4.2 Unit Stage (On-block and Onboard)

Taking up 16) condensate pump unit (machinery unit) as an example, the HLF for this unit "B4X152-----0" is listed in Fig. 6-4 (2/5), (3/5). The number "152" in the MLF-NO. is machinery number for a condensate pump given by shipyard's design standard.

This pallet of unit includes pipes, valves, expansion joints "gaskets, foundation seats for the pumps as well as two sees of condensate pumps and motors.

The all materials are assembled into one unit in the unit *assembly* shop and installed in "zone "zone Ml2" at "Blue sky stage", or in the case of IHI, the assembled machinery unit is installed on the grand block *(large* block composed of two or more unit block) which is temporarily located in the roofed unit shop for concentrated unit outfitting before erection. Connection of systems between units *are* completed *as much as* possible *at* this *stage.*

Materials to be installed by unit shall be, in general, auxiliary machinery and seats, pipes, valves and other pipe fittings in their vicinity which can be grouped into one unit with the machinery, a group of pipes running through a same zone which can be outfitted with pipe fittings, if any, on common supports, or components whose

fittings can easily be fitted in a shop before erection such as radar masts, steering gears" *or* miscellaneous tanks.

Indecision of units, the best stage at which each material is installed (on-block or onboard), location of machinery, pipes, ducts, cable etc., boundary of units, necessity and best position of make-up pieces and so forth should be taken into account.

These points are studied based on the composite drawings at planning stage, and therefore the composite drawings must be worked out paying attention to these points. For this purpose, as discussed before, the draftsmen of the composite drawings must be familiar with outfitting procedure or method at production site or collect necessary information or knowledge from production people.

4.3 Onboard Stage (Fig. 6-4 (4/5), (5/5))

The sampled pallet is "T4ZMllp--O". This MLF-No. implies this pallet is piping pallet onboard and in zone M1l. All pipes and pipe fittings located in the zone MLL are compiled in this pallet.

As may be understood, the materials to be outfitted on-board shall be;

Heavy machinery which cannot be installed at preceding stage such as main diesel engine, main boiler, main turbine, reduction gear *for* propulsion etc.

Machinery or components which cannot be installed befo the hull construction is completed. or need precise adjustment when installed such *as steering* gear, main turbine, reduction gear, rudder, propeller; propulsion shaft etc.

Deck maching except those in the machinery space or accommodation which installed at grand block stage such as windlass, mooring winches etc., or deck fittings like boat davits, masts, derrick poses etc.

° Pieces whose location, size or connection with other *systems* cannot be decided at preceding stages or are better *to* be decided at onboard *stage,* such as make-up pieces and distance pipe pieces between" machinery unit and hull shell.

° Machinery or-equipment which could be damaged stalled at preceding stages such as electric measurement equipment or furnitures.

In general, it is recommended to outfit materials as many as possible at earlier stages for better outfitting efficiency, but hull construction efficiency declines due to pre-erection outfitting to a certain extent. Shipbuilding efficiency in total span in case pre-erection outfitting is applied depends on availzbility of material preparation area and facilities, punctual receipt of materials from the vendors, close interrelation between different trades or shops, size of blocks etc. as well as size and type of the ship. Therefore careful study among every section involved is necessary as to whether and to what extent pre-election outfitting shall be applied at NASSCO.

Fig 6-4.(1/5)

MLF (On Block)

品名 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量	重量 (Kg)	梱装	引当図番 / ステージ移行	購入品コード	備考
PIPE	⑨-P-1	6"	1	165	F35			
↓	⑨-P-2	6"	1	165	↓			
	⑨-P-3	6"	1	128	F82			
	⑨-P-4	8"	1	145	F35			
	⑨-P-5	6"	1	116	↓			
	⑨-P-6	6"	1	120				
	⑨-P-7	6"	1	67				
	⑨-P-8	4"	1	30				
↓	⑨-P-9	2"	1	18	↓			
SWING CHECK VALVE	⑨-V-1	CAST IRON 125# 8"	1	160	F35			
GASKET 150# 8"			1	3				
↓ ↓ 6"			1	2				
BOLT, NUT SS W3/4"×3 1/2			8	16				

Fig 6-4 (3/5)

M L F (Unit 1/2)

品名 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量	重量 (kg)	引当図番 ステージ移行	既製品コード	備考
PIPE	⑯-P-1	1½"	1	7			
↓	⑯-P-2	↓	1	7			
	⑯-P-3		1	9			
↓	⑯-P-4	↓	1	8			
GLOBE VALVE BRONZE 1½" 150#	⑯-V-1		1	3			
↓ ↓ ↓	⑯-V-2		1	3			
BUTTERFLY VALVE CAST IRON 8" 125#	⑯-V-3		1	25			
↓ ↓ ↓	⑯-V-4		1	25			
EXPANSION JOINT RUBBER 8" 150#	⑯-E-1		1	12			
↓ ↓ ↓	⑯-E-2		1	12			
GASKET 150# 1½"			6	.6			
↓ ↓ 8"			4	.3			
BOLT/NUT SS W½"x2¼			24	2.1			
↓ SS W¾"x3½"			32	6.1			

番号	MLF-No.	作業開始日	次のステージ
77:7	B1X152---0		

設計長	パレット番号	管理番号	担当番号	頁
				1/2

Fig. 6-4 (3/5)

M L F (*Unit 2/2*)

SOT A280201 参照

品名 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量	重量	引当図番 ステージ移行	購装品コード	備考
CONDENSATE PUMP	MA-152A		2	260			
MOTOR	MP-2PA		2	86			
FOUNDATION	MD-152M	CONDENSATE PUMP	2	120			

Fig 6-4 (4/5)

M L F (On Board 1/2)

SOT-A280201参照

品名 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量	重量	引当図番 ステージ指行	購装品コード	備考
PIPE	(21)-P-1	4"	1	24			
	(21)-P-2	4"	1	22			
	(21)-P-3	1½"	1	9			
	(21)-P-4	2½"	1	10			
	(21)-P-5	10"	1	68			
	(21)-P-6	3"	1	26			
GATE VALVE CAST IRON 2½" 125#	(21)-V-1		1	6			
GASKET 150# 10"			2	.5			
4"			4	.4			
3"			2	.2			
2½"			3	.1			
1½"			2	.1			

符号	M.L.F - No.	作業開始日	次のステージ
7777	F4 2141IP--0		

担当者	パレット番号	管理番号	搭載番号	頁
				1/2

Fig 6-4 (5/5)

M L F (On Board 2/2)

SOT-A280201 参照

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量		引当図番 / ステージ保管		購装品コード			備考
BOLT/NUT SS W⅞"×3¼						24			42							
W⅝"×2¾						52			38							
W½"×2¼						8			3							
SHELL PIPE PIECE		㉑-S-1				1			12							
		㉑-S-2				1			10							
		㉑-S-3				1			8							

5. Relocation of Pipes

Yellow colored pipes in NASSCO'S drawings show examples of re-located pipes. These pipes, if arranged by IHI, would be re-located to the routes shown in the drawings (system Nos. 210-O1, 511-01, 508-02, 211-01). By this relocation each pipe can be easily included in the *respective* unit nearby the pipe.

Fig. 6-5 is another example of relocation of pipes. As shown in Fig. 6-5, pipes are staged by its location, i.e;, pipes marked B are installed on block, pipes and valves marked U-1 and U-2 are grouped into units with No. 1 and No. 2 Fresh Water Circulating Pump respectively and mak-up pipes (loose pipe) marked E are fixed on board.

The assumptions for above relocation are;

1) Machinery location is not changed.

2) Bending angle of pipes is limited to 90 or 45 degrees in principle for manufacturing of accurate pipe pieces, easiness. of drafting drawings and adjustment of make-up pipes *on* board.

3) Pump, foundation *seat* for the pump, pipes and pipe fittings *are* assembled into a unit in the unit shop and installed together. Units U-1 and U-2 are lifted by crane and installed separately on board.

4) The make-up pipes between two adjacent units, if any, are cut in required length with excess or loose flanges before erection by setting the two units in the relative position temporarily in the unit shop.

5) The make-up pipes marked E in Fig. 6-5, are measured in length on board and finished in the pipe shop thereafter

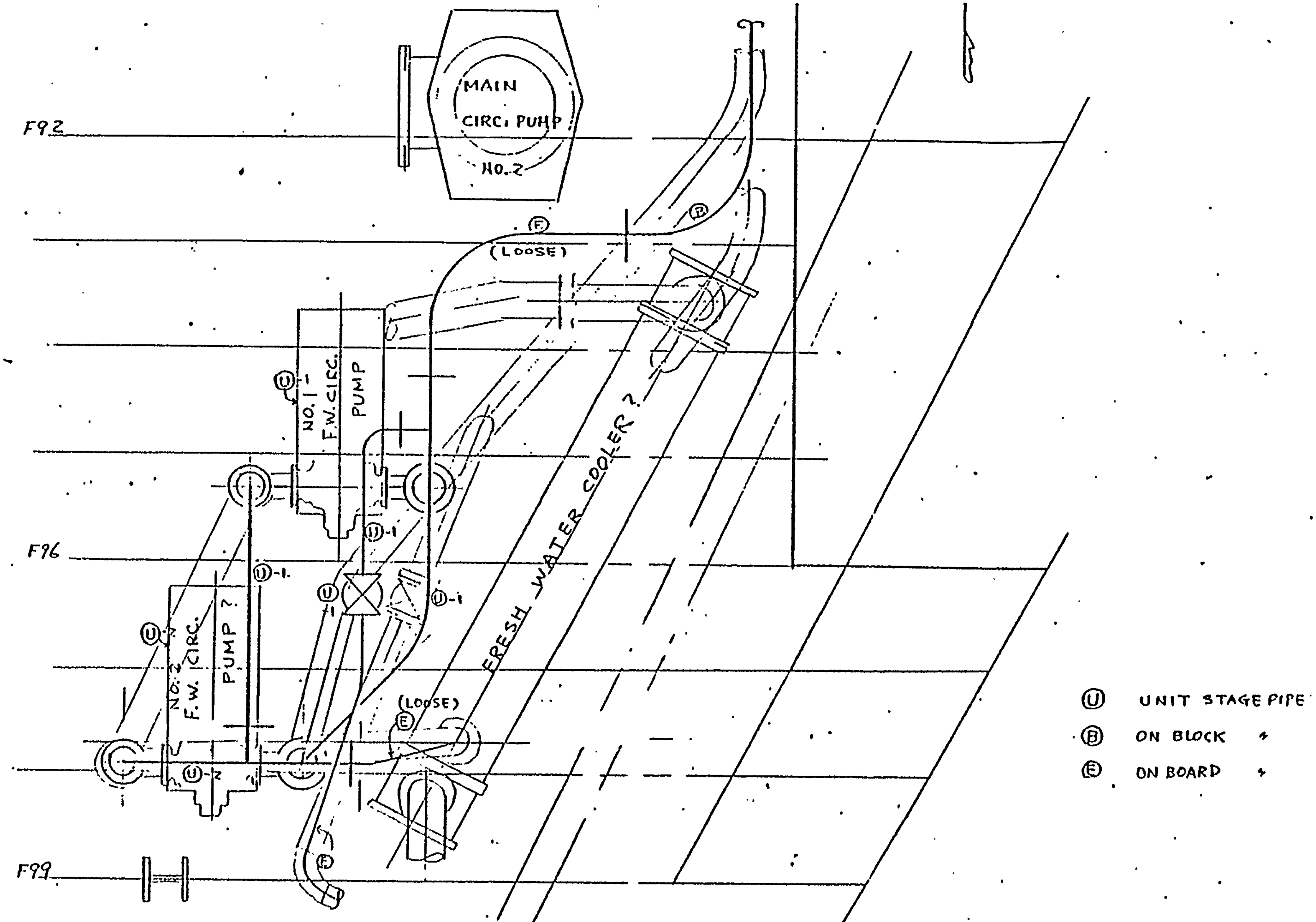


Fig 6-5 FRESH WATER PUMP UNIT

6. Other Notes on NASSCO's Drawings

In addition to the facts described already, the followings are pointed out as recommendation or reference for NASSCO

1) To make compasite drawings with minimum design manhour and error, or to maintain consistency in the quality of the drwings, development of technical standard including sysem and piece numbering standards or form of MLF is strongly recommender.

2) A composite drawing shall include all materials and necessary information for outfitting as many as possible including hull structural information such as system No., piece No., location (three dimensional) of pipe supports, fla reducers, strainers, sleeves, block joints, zone boundary, unit bouadary, pallet boundary, flow direction, work lot number, dimension and position of web frame or irregular hull structure etc.

3) TO make a composite drawing sale or to express information clearly, most of the pipes except extra large one are drawn by one line and many symbol marks for fittings are used (See example of 'IHI's composite drawing in tile fol.Lowing Chapter).

4) Computer program for developing pipe piece drawings from composite drawings used in IHI is a very powerful tool for design manhour reduction and manufacturing of accurate pipe pieces.

CHAPTER VII - AN EXAMPLE OF PALLETIZATION ON IHI'S DRAWINGS

In this chapter, an example of actual palletizztion in Xl IHI is introduced based on its composite drawings.

1. Composite Drawings

Attached two. plans are the sampled composite fitting plans of Main Floor and Lower Engine Flat of a 1,854 TEU container ship actually built in IHI Rure Shipyard recently.

Both drawings are for outfitting of *piping* system and machinery at all stages. Ventilation ducts, traffic system like passage way, electric equipment and electric cables are outfitted by other composite drawings. Identification by color is same as *NASSCO'S* example drawings.

As shown in the drawing, many materials under lower engine flat . are installed at on-block stage, and very few at on-board stage. Most of the machinery and equipment are grouped into units together with pipes and other fittings in their ViCinity. Pipes' are arranged in longitudinal and transverse direction only with a few exceptions and grouped on common supports. Such grouped pipes are assembled into units before erection.

AH systems and materials are identified by system code or piece number according to respective numbering standard of IHI which are of significant numbering system.

For example, a piece number for an auxiliary steam pipe piece is given as;

40 AS (03-265-5

- Sequential No.
- Line (Branch) No.
- System No.
- System Code (ex. As = Aux. Steam)
- Nominal Dia. (mm)

Locational information such as height of pipes above the floo or distance from the frame line is also provided. Most of the pipes except extra large ones are drawn by-one Iine with flange by scale. Machinery or *equipment are simply* drawn or symbolise but their outline or position of joints with pipes or valves etc. are clearly shown.

As may be understood instantly, IHI'S composite drwizgs conta much more information in simplified way than NASSCO'S. When implementing composite drawing system at NASSCO, Careful study of IHI drawing is recommended.

2. MLF (Figs. 7-1, 7-2, 7-3)

For each stage, one pallet in the composite drawings is taken up as an example and the MLF's thereof are shown in Figs. 7-1, 7-2 and 7-3. As for the details of each column of, MLF Article 2.4 of Chapter II is to be *referred* to. (See the attached composite drawings together.)

2.1 On-Blok Stage

Fig. 7-1 is MLF for the hull block "3D31S" at block stage of "G" (grand block). This pallet contains all materials as well as piping materials to be loaded at this stage. Ventfiation trunkS, *floor &* gratings and inclined ladders etc. are outfitted by other composite drawings than sampled piping and machinery composite drawing.

Pipe piece number is listed in MLF by shorrened form, i.e., by (System Code) ÷ (Line No.} +(Sequential Piece No-) like AS271-2, and nominal size, length, end treatment (flange, sleeve, reducer etc.) and classification are given in the specification column. Pipe piece drawing or information are printed out by the compute: and issued to the pipe fabrication shop well in advance of pallet preparation;

Units to be installed at this stage are assembled prior to pallet preparation according *to* their MLFs "B4X3D31S-J"

and “B4X3D32S-A" Details of components not shown in th composite drawings can be referred to by the reference drawings whose drawing number is given in this MLF, if necessary. for example, The details of penetration piece “FO-001" is shown by its fabrication drawing “F4070011" and ventilation trunk "NV-213Z” by fabrication drawing “F4821T21”.

Total weight of materials in this pallet except the assemb units (pallet weight) is 2,775 kgs and execution weight including the units is 4,6-11 kgs. The control weight whic is, in proportion to fitting manhour is 2,775 kg, namely in this example the pallet weight is equal to the control weight.

By referring MFL to the composite drawings the producti people. can confirm the contents of pallets and plan outfit ting schedule with appropriate resources allocacation inclu ing manhour.

2.2 Unit

Fig.7-2 lists materials assembled in a unit with the ballast pump. The MLF Of this pallet is “B4Y059-0” which is installed on the block “DS31S” at “back-assembly” stage.

The pallet weight and erection weigh: are 3,500 kgs and the control weigh: is 2,370 kgs. The control weight *iS* exclusive of the ballast pump and motor because the out-fitting manhour there for is not in proportion to their weight and calculated independently. Other descriptions are same as above 2.1 On-Block Stage.

2.3 On-Board Stage

Fig.. 7-3 is the sampled on-board pallet "T42X2LP-0". This MIS-NO. implies this is piping pallet for the zone "M21" You may easily understand this pallet by comparing the MLF With the composite drawing.

Fig.7-1 Pallet on block(1/7)

M L F

79. 06. 08

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量		引当図番 / ステージ移行		親製品コード			備考
Assembled unit CHIJ--KOGUMI-UNIT						10			4860		84X3D31S-A		MLF-NO.	of		Unit
- ditto - CHIJ--KOGUMI-UNIT						10			13500		84X3D32S-A					
											Figure of pipe piece					
Pipe		AS271-2	0		0020 1.1M 15C	10	1	1	19	P84	81	1				+
		AS271-3	0		SX11 1.8M 15C	10	1	1	34	P84	81	1				+
		AS271-4	0		X010 1.5M 15C	10	1	1	26	P84	81	1				+
		AS283-1	0		SS30 1.6M 15A 8	10	1	1	24	C84	27	1				+
		BS520-1	0		F051 4.4M 40A	10	1	1	192	G78	11	1				+
		BS520-3	0		FF31 4.1M 40A	10	1	1	190	G78	11	1				+
		BS520-4	0		FF20 1.2M 40A	10	1	1	65	G78	41	1				+
		CA262-1	0		FF20 1.7M 15A	10	1	1	34	G78	41	1				+
		CA406-1	0		FF11 5.5M 40A	10	1	1	285	G78	01	1				+
		CA409-1	0		FF20 1.9M 40A	10	1	1	108	G78	11	1				+
		CA409-2	0		FF70 3.5M 40A	10	1	1	168	G78	41	1				+

Fig. 7-1(2/7) Pallet on block

M L F

SOT-A280201 専用

79. 06. 06

品名 / 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量			重量	単位	引当図番 / ステージ作行		紙装品コード	備考
Pipe	LE001-2	0	0030 3.5M 20SC	1.0	1	1	7.9	G78	11	1		+
	LE001-4	0	S011 2.6M 65SC	1.0	1	1	33.2	G78	04	1		+
	DH651-3	0	S010 4.4M 400B	1.0	1	1	12.3	A0P	87	1		+
	F0015-1	0	FF70 2.5M 80BB 16	1.0	1	1	33.6	F64	27	1		+
	F0031-2	0	FF21 3.1M 25B	1.0	1	1	11.7	F79	11	1		+
	F0032-1	0	FF70 2.7M 25B	1.0	1	1	9.3	F79	41	1		+
	F0063-1	0	FF30 2.5M 40B	1.0	1	1	12.3	F79	41	1		+
	F0254-4	0	S020 3.8M 65C	1.0	1	1	47.9	D79	14	1		+
	F0301-2	0	0021 3.8M 250B	1.0	1	1	221.4	D79	34	1		+
	F0301-3	0	SS20 1.4M 250B	1.0	1	1	109.1	D79	57	1		+
	F0620-1	0	0F50 2.6M 25A	1.0	1	1	7.7	D79	11	1		+
	F0620-2	0	SF31 3.9M 25A	1.0	1	1	11.3	D79	41	1		+
	F0625-1	0	SS30 1.6M 65A	1.0	1	1	16.9	D79	14	1		+
	F0625-2	0	SS50 2.6M 65A	1.0	1	1	24.2	D79	14	1		+
	F0629-1	0	0021 5.9M 65A	1.0	1	1	45.2	D79	44	1		+

番	頁	MLF No	作業図番	次のステージ

	614	614	614
	76	74	2598

Fig.7-1(3/7) Pallet on block

M L F

SOT-A280201参照

	79. 06. 08

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量	荷姿	引当図番 / ステージ移行		既製品コード			備考
Pipe		FR425-1	0		OS50 3.0M 25UB	1.0	1	1	44	NOP	87	1				+
↓		FR425-2	0		OS50 2.2M 25UB	1.0	1	1	32	NOP	87	1				+
		SW049-2	0		FF20 1.6M 125A	1.0	1	1	30.5	S91	61	1				+
		SW049-3	0		FF11 3.3M 125A	1.0	1	1	61.8	S91	61	1				+
		SW049-4	0		FF20 1.0M 125A	1.0	1	1	21.6	S91	61	1				+
		SW049-5	0		FF10 2.5M 125A	1.0	1	1	43.7	S91	61	1				+
		SW216-1	0		FF10 5.2M 100A	1.0	1	1	72.6	G78	04	1				+
		SW497-1	0		FF10 5.2M 125A	1.0	1	1	85.4	S91	61	1				+
		SW497-2	0		FF20 .7M 125A	1.0	1	1	17.0	S91	61	1				+
		SW497-3	0		FF20 .7M 125A	1.0	1	1	17.0	S91	61	1				+
↓		SW497-4	0		FF20 .7M 125A	1.0	1	1	17.0	S91	61	1				+
FC ANGLE VALVE FC/BC FL 5065B		DH-606V				1.0	1	1	18.3	C79			4403C02009	1	0	+
BC GLOBE VALVE BC FGU 5040		FR-201V				1.0	1	1	6.9	NOP			5403201C07	1		+
BC S.D.C.GLOBE VALVE BC FNU 5040G		BS-247V				1.0	1	1	6.7	NOP			5403203007	1		+
BC GLOBE VALVE																

Fig.7-1(4/7) Pallet on block

M L F

SOT-A280201参照

79. 06. 0

品名 / 材質・型式・規格・寸法	部品符号	引出指示項目（コメント）	数量			重量	仕	引当図番 / ステージ移行	購入品コード		備考
BC GLOBE VALVE BC . FGU 16040	CA-512V		1.0	1	1	8.7	NOP		5403221C07	1B	+
BC S.D.C.GLOBE VALVE BC FNU 16015G	AS-270V		1.0	1	1	2.7	NOP		5403223003	1B	+
.10K HOSE GLOBE VALVE BC ANSI HG 1015.	CA-247V		1.0	1	1	2.3	NOP		1404501253	1B	+
BLIND FLANGE SS41 FB 10K 15SS			1.0	1	1	0.6	C79		5406511103	1B	+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-001		1.0	1	1	12.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-002		1.0	1	1	12.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIRE)	FO-003		1.0	1	1	8.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIRE)	FO-004		1.0	1	1	8.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-005		1.0	1	1	32.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-006		1.0	1	1	4.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-007		1.0	1	1	5.0	D42	F4070011	2407C19000		+
PENET.PIECE(STEEL PIPE) PENET.PIECE(STEEL PIPE)	FO-008		1.0	1	1	2.0	D42	F4070011	2407C19000		+
EXPANSION JOINT,BELLOWS EXP.J.SUS FREE 5K 500	GE-001K		1.0	1	1	87.4	NOP		1408050721	1B	+
GASKET ASBESTOS PA 5K 400U			5.0	1	1	0.0			5408401107	1B	+
GASKET ASBESTOS PA 5K 1250U			9.0	1	1	0.9			5408401113	1B	+

番号	MLF－No	作業開始日	次のステージ		重量	パレット重量	管理重量	搭載重量	頁
						186	186	186	
	F4C...	79. 01. 2		ZA03 1 D 7 42 PNO. 17		1354	1354	1192	4

Fig.7-1(5/7) Pallet on block

M L F

SOT-A280201

79. 06. 08

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量		引当図番 / ステージ移行	購装品コード			備考
GASKET ASBESTOS PA 10K 150U			10	1	1	0.0			54GE411103	1	0	+
GASKET ASBESTOS PA 10K 250U			50	1	1	0.0			5408411105	1	0	+
GASKET ASBESTOS PA 10K 400U			40	1	1	0.0			5408411107	1	0	+
GASKET ASBESTOS PA 10K 800U			10	1	1	0.1			540E41111C	1	0	+
GASKET ASBESTOS PA 10K 1000U			11	1	1	0.1			5408411112	1	0	+
SCUPPER FOR STEEL DECK SCUPPER SS 1BF 5K 40G	BS/401K		40	1	1	4.6	603		5408631C77	1	0	+
SCUPPER FOR STEEL DECK SCUPPER SS 2F 5K 40G	BS/408K		10	1	1	8.0	603		4408636127	1	0	+
SCUPPER FOR OIL PAN SCUPP/OIL PAN SS 10K 25	FO-631K		10	1	1	1.5	056		4408637405	1		+
SCUPPER FOR OIL PAN SCUPP/OIL PAN SS 10K 25	FO-645K		10	1	1	1.5	056		4408637405	1		+
SCUPPER FOR OIL PAN SCUPP/OIL PAN SS 10K 25	FO-646K		10	1	1	1.5	056		4408637405	1		+
HEXAGON HEAD BOLT/NUT SS GALV.BN 12S 40SG			220	1	1	2.2	600		5409217311	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 45SG			140	1	1	1.4	600		5409217512	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 50SG			840	1	1	8.4	600		540921751[illegible]	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 55SG			120	1	1	2.4	600		5409217514	1	0	+

Fig.7-1(6/7) Pallet on block

M L F

79. 06. 08

品名 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量	指装	引当図番 ステージ移行	納装品コード	備考
SPINDLE DEVICE SPIND E DEVICE	NM-721Z		1.0	1	1	5.0	033	F4606914	2460600000	+
PIPE BAND SUPPORT PIPE BAND SUPPORT		N=92	1.0	1	1	291.0		F4634T11	24634CCCCC	+
EYL PLATE EYL PLATE	NL-080P		2.0	1	1	31.4	064	F4805211	1480521CC0	+
VENTILATION TRUNK VENTILATION TRUNK	NV-213Z		1.0	1	1	111.2	004	F4821T21	2482100000	+
VENTILATION TRUNK VENTILATION TRUNK	NV-214Z		1.0	1	1	82.1	004	F4821T21	24821CCCCC	+
FLOOR & GRATING FLOOR & GRATING	NG-120C	F図参照，取付は	1.0	1	1	79.0		F4831Z31	248310C0C0	+
FLOOR & GRATING FLOOR & GRATING	NG-121C	交通装置取付図．	1.0	1	1	76.0		F4831Z31	24831CC0C0	+
FLOOR & GRATING FLOOR & GRATING	NG-122C		1.0	1	1	54.0		F4831Z31	24831CC000	+
FLOOR & GRATING FLOOR & GRATING	NG-123C		1.0	1	1	46.0		F4831Z31	248310C000	+
FLOOR & GRATING FLOOR & GRATING	NG-124C		1.0	1	1	60.0		F4831Z31	248310CC00	+
FLOOR & GRATING FLOOR & GRATING	NG-211Z		1.0	1	1	112.0		F4831Z71	2483100000	+
FLOOR & GRATING FLOOR & GRATING	NG-311Z		1.0	1	1	42.0		F4831Z71	248310C000	+
INCLINED LADDER INCLINED LADDER	NG-211L	LA-3 H/2500 B/600 A/55	1.0	1	1	117.0	004	F48321C1	248321CC00	+
INCLINED LADDER INCLINED LADDER	NG-212L	LA-3 H/2650 B/500 A/55	1.0	1	1	115.9	004	F4832101	248321CCC0	+
INCLINED LADDER INCLINED LADDER	NG-311L	LA-3 H/2600 B/600 A/55	1.0	1	1	124.3	004	F4832101	248321C000	+

番 船	MLF - No	作業開始日	次のステージ	出図日	パレット重量	合計重量	総計重量	頁
					1348	1348	1348	
		19 01			2727	2737	4573	

Pallet on block

名 / 寸法	区分	部品符号	加工	前	引当指示項目（コメント）	数量	単位	係	重量	仕装	引当図番 / ステージ代行	引当	区分	仕装品コード	区	区	備考
		NL-2411A			FOR DIESEL GENERATOR	10	1	1	111	004	F4897241		1	48572C000			+
		NC-001C				20	1	1	44	003	F4859T11		1	485574300			+
		NC-002C				20	1	1	52	003	F4859T11		1	485574300			+
		NC-003C				10	1	1	41	003	F4859T11		1	485574300			+
		NC-004C				10	1	1	46	003	F4859T11		1	485574300			+
		NC-005C				10	1	1	83	003	F4859T11		1	485574300			+

作成年月日: 79. 06. 0[illegible]

作業開始日	次のステージ	出場日	パレット番号	管理番号	仕様番号

Fig.7-2(1/4) Machinery unit

M L F

SOT-A280201参照

作成年月日
79.06.06

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量	依数	引当図番 / ステージ移行		既製品コード			備考
Pipe		AS263-5	U		FF50 3.9M 40A 15	10	1	1	183	D84	27	1				+1
		AS263-6	U		FF30 2.0M 40A 15	10	1	1	109	D84	27	1				+
		BS202-3	0		FF70 3.9M 200B	10	1	1	1767	R44	44	1				+
		BS203-9	0		FF20 2.4M 200B	10	1	1	1170	R44	44	1				+
		BS210-2	U		FF70 3.3M 200B	10	1	1	1543	R44	44	1				+
		F0253-1	0		FF30 3.3M 250B	10	1	1	2186	D42	34	1				+
		SW404-4	U		FF20 1.2M 300A	10	1	1	906	S92	61	1				+
		SW404-5	U		FF20 .6M 300A	10	1	1	532	S92	61	1				+
		SW404-6	0		FF20 .4M 300A	10	1	1	435	S92	61	1				+
		SW429-2	0		FF20 1.0M 125A	10	1	1	223	S92	61	1				+
		SW429-3	0		FF20 .6M 125A	10	1	1	166	S92	61	1				+
		SW429-4	U		FF20 .7M 125A	10	1	1	174	S92	61	1				+
		SW429-5	U		FF20 .4M 125A	10	1	1	136	S92	61	1				+
		SW429-6	U		FF20 .5M 125A	10	1	1	151	S92	61	1				+
		SW451-7	U		FF21 2.6M 400A	10	1	1	2885	S94		1				+

番 号	MLF - No	作業開始日	次のステージ
...	..Y059---0	79 01 2.	F..DS315-0

ZU01 2 A 7 42 PNO. 10

重量区分	パレット重量	管理重量	搭載重量	頁
	1257	1257	1257	
	1257	1257	1257	1

Fig.7-2(2/4) Machiner unit

M L F

79. 06. 0

品名 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量			重量	種類	引当図番 ステージ移行		購入品コード			備考
Pipe	SW452-1	0	FF11 .7M 300A	10	1	1	1076	S92	61	1				+
	SW458-1	0	FF21 .9M 250A	10	1	1	863	S92	61	1				+
	SW458-2	0	FF20 .9M 250A	10	1	1	630	S92	61	1				+
	SW460-1	0	FF10 .7M 250A	10	1	1	484	S92	61	1				+
BC GLOBE VALVE BC FGU 16025	SW-413V			10	1	1	57	AOP			540322100S	1	0	+
BC SCREW/BITE GLOBE V. BC M-SCR, FGT 20010SBC	SW-412V			10	1	1	10	AOP			440324SC02	1	0	+
SC/BC SHELL V.LINING SC/BC SHELL V.LINING	SV-439V		10K-250	10	1	1	2590	D42	N4041000A		140419C000			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)	SW-456V		FC25 SCS13 5K * 250	10	1	1	500	D42	N4044000		140445CCCU			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)	SW-459V		FC25 SCS13 5K * 300	10	1	1	400	D42	N4044000		140445CCCC			+
BUTTERFLY VALVE(MANUAL) BUTTERFLY VALVE(MANUAL)	SW-460V		FC25 SCS13 5K * 300	10	1	1	400	D42	N4044000		140445C000			+
BLIND FLANGE (W/HANDLE) SS41 GALV.FB 5K 300SSI				10	1	1	270	R44			440651C187	1	A	+
WATER FILTER WATER FILTER	SW-402S		5K-250C BALLAST PP	10	1	1	2460	D42	N4002400		140625CSCU			+
GASKET ASBESTOS PA 5K 1250U				60	1	1	06				540840111S	1	0	+
GASKET. ASBESTOS PA 5K 2000U				30	1	1	03				540840111S	1	0	+
GASKET														

Fig.7-2(3/4) Machinery unit

M L F

79. 06. 00

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量	出装	引当図番 / ステージ作行	購装品コード			備考
GASKET ASBESTOS PA 5K 3000UT			60	1	1	1.8			5408401167	1	0	+
GASKET ASBESTOS PA 5K 3500UT			10	1	1	0.4			5408401168	1	0	+
GASKET ASBESTOS PA 5K 4000UT			10	1	1	0.5			5408401169	1	0	+
GASKET ASBESTOS PA 10K 400J			20	1	1	0.0			4408412107	1	0	+
GASKET,RUBBER SHEET GASKET,RUBBER SHEET	CW/001PP	5K-300 FOR LINING	10	1	1	1.0	A01	N4084900A	1408492000			+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 50SG			520	1	1	52	600		5409217513	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 20S 60SG			240	1	1	72	600		5409217615	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 20S 65SG			600	1	1	180	600		5409217616	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 20S 70SG			540	1	1	162	600		5409217617	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 22S 70SG			60	1	1	24	600		5409217717	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 22S 75SG			220	1	1	88	600		5409217718	1	0	+
BALLAST PUMP BALLAST PUMP	MA-059AA	VEC 500M3/H * 25M	10	1		5900		N4451060A	1445106000			+
MOTOR (BALLAST PUMP) MOTOR (BALLAST PUMP)	P/BTP-M	55KW 1800RPM TE V B	10	1		5400		N4451070	1445107000			+
PIPE BAND SUPPORT PIPE BAND SUPPORT		N=12	10	1	1	852		F4634802	2463400000			+
VERTICAL LADDER VERTICAL LADDER	NG-102V	VFS-5 L/700 舷側梯	10	1	1	970	33	F4830214	2483020000			+

番	MLF-No	作業開始日	次のステージ
3726	64Y059---	79 01 23	T6HDS415-0

7U01 2 A 7 42 PNO 12

	1286	156	1286	
	3500	2370	3500	3

Fig.7-2(4/4) Machinery unit

M L F

品名 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量	塗装	引当図番 ステージ移行		購入品コード			備考
FLOOR & GRATING FLOOR & GRATING		AG-049C			多角装置取付図	10	1	1	920		F4831010		2483100000			+
FLOOR & GRATING FLOOR & GRATING		AG-102C				10	1	1	213		F4831010		2483100000			+
AUX MACHINE SEAT AUX MACHINE SEAT		ND-059M			BALLST PUMP	10	1	1	3280	633	F4858059		2485810000			+

79. 06. 08

Fig.7-3(1/8) Pallet on board

M L F

79. 06. 08

品名 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量			重量		引当図番 ステージ移行		購入品コード	備考
Pipe	AS263-1	0	FF30 3.3M 40A 15	10	1	1	160	D84	27	1		+
↓	AS263-2	0	F020 .8M 40A 15	10	1	1	5.1	D84	27	1		+
	AS281-1	2	SS10 1.6M 25A 8	10	1	1	46	D84	27	1		+
	AS306-11	2	FF20 2.0M 80A 15	10	1	1	241	D84	27	1		+
	BS452-1	0	FF70 2.9M 40A	10	1	1	130	G78	41	1		+
	BS528-1	4	FF10 2.6M 40A	10	1	1	122	G78	01	1		+
	CA012-1	0	FF30 1.6M 25C 41	10	1	1	80	G78	24	1		+
	CA013-1	3	FF10 2.0M 25C 41	10	1	1	91	G78	91	1		+
	CA013-2	1	FB12 .1M 25C 41	10	1	1	28	G78	24	1		+
	CA225-1	0	FF30 1.6M 25A	10	1	1	63	G78	11	1		+
	CA272-1	0	FF30 2.1M 15A	10	1	1	39	G78	11	1		+
	CA407-1	0	FF50 2.6M 40A	10	1	1	133	G78	41	1		+
	CE001-3	0	S010 2.3M 20SC	10	1	1	53	G78	01	1		+
	CE001-4	4	SS50 2.2M 65SC	10	1	1	319	G78	44	1		+
↓	CE001-7	0	S010 1.5M 20SC	10	1	1	36	G78	01	1		+

番	MLF - No	作業開始日	次のステージ
2226	F4/M21P--(	79 02 24	

PALLET ON · BOARD

/E02 1 D 7 42 PNO : 34

	パレット重量	管理重量	搭載重量	頁
	159	159	159	
	159	159	159	1

Fig.7-3(2/8) Pallet on board

M L F

19.06.08

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量	塗装	引当図番 / ステージ移行		艤装品コード			備考
Pipe		CW051-1	3		FF20 1.6M 80B	1.0	1	1	22.1	G76	91	1				+
		CW051-2	0		FF20 2.2M 80B	1.0	1	1	29.8	G76	44	1				+
		CW051-3	0		F030 3.3M 50C	1.0	1	1	26.0	G76	11	1				+
		CW051-4	0		FF10 .1M 50C	1.0	1	1	3.7	G76	01	1				+
		CW121-1	0		FF50 2.2M 40C	1.0	1	1	13.7	G76	11	1				+
		DR649-1	0		0S70 3.7M 65A 8	1.0	1	1	30.4	D84	27	1				+
		DR693-1	0		F010 .3M 50C 15	1.0	1	1	4.2	D84	27	1				+
		DW651-1	2		SS70 2.6M 40UB	1.0	1	1	7.9	NOP	87	1				+
		EX418-2	3		FF21 1.9M 700ED	1.0	1	1	513.9	D79	91	1				+
		EX420-2	0		FF30 1.8M 65A	1.0	1	1	16.9	D84	14	1				+
		FD190-1	2		S070 3.1M 25A	1.0	1	1	8.0	D79	41	1				+
		FD216-1	0		S050 1.8M 50A	1.0	1	1	10.6	D79	11	1				+
		FD231-1	1		FF20 1.4M 65A	1.0	1	1	14.8	D79	44	1				+
		FD251-15	0		0S30 4.1M 15A	1.0	1	1	5.6	G76	11	1				+

Fig.7-3(3/8) Pallet on board

M L F

SOT-A280201参照

日付: '79. 06. 08

品名 / 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量			重量	仕装	引当図番 / ステージ移行		購製品コード	備考
Pipe	FH002-1	4	SS50 4.1M 400B	1.0	1	1	12.0	A0P	87	1		+
↓	F0015-1	0	FF20 2.0M 800B 16	1.0	1	1	37.5	F84	27	1		+
	F0018-3	0	FF20 .0M 800B	1.0	1	1	10.8	F84	34	1		+
	F0018-4	0	FF20 .9M 800B	1.0	1	1	14.4	F84	34	1		+
	F0018-5	0	FF10 3.3M 800B	1.0	1	1	41.2	F84	04	1		+
	F0629-1	0	FF20 3.5M 250	1.0	1	1	11.2	F79	11	1		+
	F0031-3	1	FF20 .9M 250	1.0	1	1	5.0	F79	41	1		+
	F0031-4	0	FF20 .5M 250	1.0	1	1	3.7	F79	41	1		+
	F0033-1	0	FF20 3.8M 250	1.0	1	1	12.0	F79	11	1		+
	F0254-1	1	FS50 1.7M 65C	1.0	1	1	25.6	D79	44	1		+
	F0282-1	1	F020 .8M 250B	1.0	1	1	60.2	D79	95	1		+
	F0282-2	0	0020 2.1M 250B	1.0	1	1	126.0	D79	95	1		+
	F0301-1	1	FS20 1.5M 250B	1.0	1	1	115.6	D79	34	1		+
	F0629-1	2	SS30 1.9M 65A	1.0	1	1	18.5	D79	44	1		+
↓	FR216-1	0	FF20 4.0M 40B	1.0	1	1	18.4	G78	11	1		+

番	MLF-No	作業開始日	次のステージ
2726	F47021P--	79.02.22	

ZE02 1 D 7 42 PNO. 36

	重量	管理重量	搭載重量	
	512	512	512	
	1396	1396	1376	3

Fig.7-3(4/8) Pallet on board

M L F

SOT-A280201参照

作成年月日: 79. 06. 0[illegible]

品名 / 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量	単位		重量	指数	引当図番 / ステージ代行		積装品コード	備考
Pipe	FR232-1	1	FF61 1.7M 20B	1.0	1	1	.4.6	G78	41	1		+
	FR233-1	0	FF50 2.3M 20B	1.0	1	1	5.6	G78	41	1		+
	FR259-4	3	FF20 1.1M 80B	1.0	1	1	16.8	G78	91	1		+
	FR402-1	2	SS30 1.6M 400B	1.0	1	1	5.2	NOP	87	1		+
	FR408-1	2	SS30 1.6M 400B	1.0	1	1	5.2	NOP	87	1		+
	FR473-1	2	SS30 1.6M 400B	1.0	1	1	5.2	NOP	87	1		+
	GE011-1	1	FS50 1.7M 500EB	1.0	1	1	234.9	D84	57	1		+
	L0261-1	3	FB10 1.5M 65A	1.0	1	1	18.6	D79	91	1		+
	L0261-2	3	FB10 1.5M 65A	1.0	1	1	18.6	D79	91	1		+
	SW049-1	3	FF20 1.6M 125A	1.0	1	1	30.6	S91	91	1		+
	SW049-6	4	FF20 1.0M 125A	1.0	1	1	23.0	S91	61	1		+
	SW157-11	0	FF10 3.2M 65A	1.0	1	1	26.8	S91	61	1		+
	SW157-14	3	FF20 .5M 65A	1.0	1	1	6.8	S91	91	1		+
	SW157-13	0	FF10 4.1M 65A	1.0	1	1	33.5	S91	61	1		+

Fig.7-3(5/8) . Pallet on board

M L F

作成年月日	79, 06, 08

品名 / 材質・型式・規格・寸法	部品符号		引当指示項目（コメント）	数量			重量	作業	引当図番 / ステージ移行	舾装品コード			備考
Pipe	SW215-1	3	FF20 2.0M 150A	1.0	1	1	51.9	G70	91				+
	SW216-1	3	FF50 2.3M 100A	1.0	1	1	34.6	G70	91				+
	SW236-1	3	FF20 .9M 65A	1.0	1	1	12.3	G70	91				+
	SW241-1	0	FF10 3.6M 125A	1.0	1	1	60.2	S91	61				+
	SW497-5	3	FF20 .9M 125A	1.0	1	1	21.1	S91	91				+
BC GLOBE VALVE BC FGU 16025	FO-007V			1.0	1	1	5.7	NOP		5403221005	1	0	+
SF SCREWED GLOBE VALVE SF M-S FGU 40006C	CA-056V			1.0	1	1	1.5	NOP		1403341051	1	C	+
SF GLOBE VALVE SF/SUS FGU 20025	CA-001V			1.0	1	1	7.1	D75		4403345005	1		+
SPECTACLE FLANGE (SS) SPECTACLE FLANGE (SS)	EX-001F		5K-700 SS	1.0	1	1	94.7		N4C69291	1406529100			+
SIGHT GLASS SIGHT GLASS FC 5K 50	CW-005K			1.0	1	1	3.3	D79		4408351CC6	1		+
GASKET ASBESTOS PA 5K 400U				4.0	1	1	0.0			5408401107	1	0	+
GASKET ASBESTOS PA 5K 500U				2.0	1	1	0.0			5408401108	1	0	+
GASKET ASBESTOS PA 5K 650U				8.0	1	1	0.0			5408401109	1	0	+
GASKET ASBESTOS PA 5K 800U				6.0	1	1	0.6			5408401110	1	0	+
GASKET ASBESTOS PA 5K 1250U				4.0	1	1	0.4			5408401113	1	0	+

番号	MLF No	作業期日	次のステージ

	293	293	293	
	2159	2159	2159	

ZC02 1 8 7 42 PNO. 36

Fig.7-3(6/8) Pallet on board

M L F

SOT-A250201

79. 06. 0

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量	集装	引当図番 / ステージ移行		航装品コード			備考
GASKET ASBESTOS PA 5K 2500U			2.0	1	1	0.4			5	408401116	1	B	+
GASKET ASBESTOS PA 5K 650J			2.0	1	1	0.0			4	408402109	1	B	+
GASKET ASBESTOS PA 5K 7000J			1.0	1	1	1.0			4	406402175	1	B	+
GASKET,WIRE NET INSERT. ASBESTOS PA 5K 5000GT			1.0	1	1	1.2			4	408404171	1	A	+
GASKET ASBESTOS PA 10K 150U			1.0	1	1	0.0			5	408411103	1	B	+
GASKET ASBESTOS PA 10K 200U			2.0	1	1	0.0			5	408411104	1	B	+
GASKET ASBESTOS PA 10K 250U			5.0	1	1	0.0			5	408411105	1	B	+
GASKET ASBESTOS PA 10K 400U			1.0	1	1	0.0			5	408411107	1	B	+
GASKET ASBESTOS PA 10K 650U			1.0	1	1	0.1			5	408411109	1	B	+
GASKET ASBESTOS PA 10K 800U			1.0	1	1	0.1			5	408411110	1	B	+
GASKET ASBESTOS PA 10K 1000U			1.0	1	1	0.1			5	408411112	1	B	+
GASKET ASBESTOS PA 10K 1500U			1.0	1	1	0.1			5	408411114	1	B	+
GASKET ASBESTOS PA 10K 400J			2.0	1	1	0.0			4	408412107	1	B	+
GASKET ASBESTOS PA 10K 500J			1.0	1	1	0.0			4	408412108	1	B	+

Fig.7-3(7/8) Pallet on board

M L F

79. 06. 0

品名 / 材質・型式・規格・寸法	部品符号	引当指示項目（コメント）	数量			重量	仕装	引当図番 / ステージ移行	購装品コード			備考
GASKET ASBESTOS PA 20K 25IU			30	1	1	00			4408441605	1		+
GASKET,ASBESTOS SHEET GASKET,ASBESTOS SHEET	CA/011FF	D/G MAIN AIR START.V.	10	1	1	10	NOP	N4084900	1408491000			+
GASKET,ASBESTOS SHEET GASKET,ASBESTOS SHEET	LO/201FF	D/G MIST GAS OUTLET	20	1	1	20	NOP	N4084900	1408491000			+
HEXAGON HEAD BOLT/NUT SS GALV.BN 12S 40SG			200	1	1	20	GOO		5409217311	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 12S 45SG			340	1	1	34	GOO		5409217312	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 45SG			460	1	1	46	GOO		5409217512	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 50SG			440	1	1	44	GOO		5409217513	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 16S 55SG			280	1	1	56	GOO		5409217514	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 20S 60SG			40	1	1	12	GOO		5409217615	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 20S 65SG			200	1	1	60	GOO		5409217616	1	0	+
HEXAGON HEAD BOLT/NUT SS GALV.BN 24S 80SG			240	1	1	120	GOO		5409217820	1	0	+
HEXAGON HEAD BOLT/NUT S45C BN 22S 75SF			100	1	1	40			4409517718	1	0	+
BOLT STUDS/NUT S45C BN 16S 75DSF			100	1	1	20	EOO		4409527518	1	0	+
ACCESS (MAIN DIESEL) ACCESS (MAIN DIESEL)	MV-001AA	AIR COOLER DRAIN VALVE	10	1		300		N4111010 A	1411108000			+
PIPE BAND SUPPORT PIPE BAND SUPPORT		N=36	10	1	1	540		F4634221 A	2463400000			+

部 編	MLF-No	作業開始日	次のステージ
	L/M ?IP-	79 02 2	

7E02 1 D 7 42 PNO. 40

重量	パレット重量	管理重量	搭載重量	頁
	172	142	172	
	2334	2304	2334	7

Fig.7-3(8/8) Pallet on board

M L F

SOT-A200201 参照

品名 / 材質・型式・規格・寸法		部品符号			引当指示項目（コメント）	数量			重量	梱装	引当図番 / ステージ			購入品コード			備考
VENTILATOR TERMINAL TERMINAL & PIECE 400X300		NV-806D				30	1	1	363	D04				2482141143	1	B	+
VENTILATOR TERMINAL TERMINAL & PIECE 500X400		NV-807D				10	1	1	160	D04				2482141154	1	B	+
VERTICAL LADDER VERTICAL LADDER		NG-211V			VFS-5 L/4420	10	1	1	610	D04	F4830210			2483C2C000			+

作成年月日 79. 06. 0d

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume IV
- Palletization -
Addendum

October, 1979

IHI

Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

CONTENTS

ADDENDUM

CHAPTER I - PREFACE

From August 6 to 31, 1979, IHI engineers stayed at NASSCO for presentation and discussion on palletization based on their prepared text book "PalletIzatiOn" z This addendum supplements *the* text book finalized through discussions with NASSCO people and covers some additional topics discussed in the meetings for review and reference.

The recommendation prepared by NASSC0 at the end of out stay is attached *to* this addendum as *a* reference.

It should be stressed that we wish and are sure that NASSCO will enjoy conspicuous improvement in productivy if all NASSCO people from the top management to the production workers fully understand the concept and procedure of palletization as presented by us and palletization is gradually implemented according to the detailed program to be carefully made based on the recommendations with necessary modifications thereto in course of implementation, if any. We have to also mind you that it is NASSCO'S responsibility to decide how and to what extent palletization shall be implemented including reformation of organization, application of pre-erection outfitting, selection of ships and zones to which palletizacion shall be applied (step by step), education and training of personnel etc. and to track and evaluate the results.

CHAPTER II - MANHOUR SAVING IN DESIGN ENGINEERING

Palletization is a means to make production jobs simple-. By utilizing palletization systematically jobs can be shifted from the bands of trained *workers* to those of untrained workers.

Practices, "knowhows and many other knowledges for outfitting which trained workers usually-have are *transferee* to untrained workers through explanation of the drawings. As *a* matter of fact, good productivity is almost brought *from* good drawing which is productio oriented.

This means actually that good amount of information for production has to be moved from the work force to the design office. A deiesg has to spend his time *more for thinking of the* grouping of material a unit, suitable location of boundaries between the groups of mater the best sequence for installation, additional reinforcement for the unit, location of pipe joints, location of scafoldiag etc.

It burdens the design department more manhour. Even though we can save comparatively a large production manhour *at* the sacrifice of design department, .i.e, increase in design manhour. Of course, we have to make utmost efforts to minimize the increase in design manho *as* much as possible by rationalizing. design procedure or introductio of improved techniques.

It can be approached by following ways:

Standardization

Computerization

Photographic technique

Reducing number of the drawings

Editing design:

Standardization is one of the most useful ways to reduce the *design* manhour: when it is applied to various areas relating to design/such as material design, functional design calculation, making,diagrams material listing for a pallet, material as sembling for a unit,: design procedure, vendors drawings if possible etc.

Computarization is also powerful for reducing manhour, when it is applied to production oriented design such as material listing, pipe piece drawing and its material listing, electric wiring drawing and its material listing etc.

Photograph is also useful especially"for preparation of production oriented drawings such as making composite drawings or developing working drawings from composite drawings.

Reducing number and kind of drawings is also-effective for manhour savement.

Design manhour is approximately in direct propotion to the number of drawings. Principally, production oriented design requires more number of drawings than convencional design, because the drawings

are issued, in principle, by zone, stage and trade not by *system only*. But, it is just a principle, so actually the drawings by zone, trade and stage can be combined into one drawing if the place is not conges by outfitting materials, For example, one drawing can include sever zones, stages and trades. But the planning (i.e. making drawing list) should be so made as the combined drawings do not give the work forces *any* inconveniences for their use of the working drawings for instal lacion.

Now,.we explain a concept of the Editing Design .
The Editing Design is one of the approaches to reducing design manhou as well as keeping good design quality by accumulation of experiences It means that the drawing is, as much as possible, completed by only edditing standards or composing parts of drawing, which *are well* organized to reform a new design by means of combination of *the* previously prepared standards or moduled design. In other words, t "Edditing Design" is an attempt *to* complete a *drawing by paste* and scissors instead of a pencil and a ruler.

CHAPTER III - MATERIAL PROCUREMENT

1. In-Time Preparation of Materials

One of the key points to improve the productivity of outfitting jobs is preparation of materials in time.
If-we can prepare all materials necessary for a work before starting, we can easily accomplish the work by the most productive way and save manhour. But if we can not, the missing materials will not allow the most productive way for our work and cause the idle time for waiting the coming of the materials. This is essential.
If material preparation is perfect,. the productivity could easily go up without any implementation of new method such as palletiza- tion.

Good material preparation can be,achieved by a good material control system supported by people in-all. organization throughout the shipyard. Because good results can only be produced from good data which-are fed by people through the computer system.
Therefore, people who relate to production - sales, design, material control, planning, scheduling - as well as foremen and . workers shall have high interest in the in-time preparation of materials and positively contribute to their role to be done in both formal and informal communication route.

Designer shall have the greatest interest in the material procurement,

The material procurement starts from *the* design *phase* - material design, vendor evaluatim selection, material listing etc.
For example, as soon as a contract of a new ship is awarded to th shipyard, the initial designers (scientific) have to list the pariicular materials to give a prior notice ---- to the people ir detail design, material control and production department because to prepare the listed materials in time is important for giving the shipyard profit.

This list has to lise:

Materials which have long lead time,

Materials delay of which must give a considerable negative *impact to* productivity,

Materials which are expensive,

Materials cost of which would be abruptly changed in near " future, etc.

Some times; a *part of this* list must be made even while a negotiat between a shipyard and a ship's owner is going, on, when the aegotiation is going too late *or* when the in-time preparation *for some* materials seems to be difficult because of a strong seller's market.

This list shall be made by the help of the people in material cont and production.

Material control people shall have special attention to these particular materials *for* their preparation.

At the time to determin priority of material procurement, all materials shall be evaluated very carefully; considering two points mainly . One. is the *cost.* If some particular material is expensive, it is of course important to make an effort to reduce the cost by negotiation with the vendor because it could give us big profit without any effort in prociuction. Another is degree of influence over the productivity if a material would not be prepared before starting a job. In case-that some material is one of the parts located at the end of an assembly, delay or lack of the material . during the work does not cause manhour losses so much, because the jobs can be continued without that *material* and without any chahge of work sequences regardless: its *cost.*

But if the material is *located at* the center part of the assembly, delay or lack of the material. will disturb all of the assembly jobs and cause a lot of idle time for waiting the material., changing work sequence or rearranging work order.

2. Evaluation of the *Cost* of Material

When *a* vendor is going to be decitied by its offered specificatio and price evaluation of material cost *shall be* carefully done b taking consideration of both material cost-and installation cost 1 It is noticed that person in charge of material purchasing has a tendency-to select cheapest material ignoring its installation co because of his tight budget,

People in production should have much interest in *the* in-time preparation of material. At the beginning of the production pla ning, their task about materials is to let the design people kno what materials are vital for their installations. During the production, they have to pay attetion *to* storing, receiving or manufacturing situation of the *vital* materials not only inside shipyard but also manufacturers shop and to inform material expediter of critical delivery date to keep their schedule. For it is the production people who is best aware of the importa of punctual receipt of materials and troubled by delay of materi most seriously. And if they find any problems in material prepa tion (manufacturing, receiving from vendors or storing) they h *to warn* the material expediter of the problems. The material expeditor must always track situation of material preparation and if any problem are perceived he should warn the vendor or manufacturer of the problem without delay and, at the same time, inform the production people of she same problems for

them to cope with the situation by adjusting outfitting schedule or changing job sequence in well advance. Becacse manufacuring of marerial has wide relationship between various organzations such as shipyard organizations for material procurement, vendors, manufac-turexs, raw material suppliers, parts suppliers and so on.

CHAPTER IV - TECHNIQUE FOR SCHEDULING
(PERT VS BAR-CHART)

For scheduling technique of today, the "PERT" is a very popular metho as well as the conventional bar-chart method. PERT is a very useful and powerful tool when it is applied to project type jobs, for exampl development of a particular technology, *research* for some manufacturi procedures, inovacion of materials etc. be cause of reasons;

1) Activities and events composing a network can not be defined previously. Sometimes new activieies are added And originaliy scheduled ones deleted while the job is carrying Out BEecause, in the project type job planning, nobody can completely defi all activities beforehand because there can exist many un-known factors.

Manhours and resources required for completion of each activity difficult to be estimated.
Sometimes *manhours* and resources allocated to the each activity are positively changed to comply with unexpected matters such as unexpected results, discoveries etc. because, flexibility is the most important thing for the control of this kind of jobs.

(paths?)

The critical passes are not clear, because the network *for* these jobs are *always new and* important thing is study of network . itself.

On the contrary, when the PERT is applied to routine *type of* jobs such as shipbuilding, "PERT" method is not so powerful because:

1) Actities and events composing a nerwork are usually very clear.

2) A shipyard has many experiences. The workers are continuously building ships in proved *ways.* Planners and schedulers know all necessary activities and events in detail. Even in the case of a new type ship building, all they have to do will be only partial correction of standard schedule.

3) Manhours and resources are very steady.
We have good parameter for the manhour calculation and know well how to allocate or how to plan resources;

4) The critical passes are clear, because we" know the shipbuilding process very well. through many experiences.

In addition to the aboves, the bar-chart type scheduling is superior to the "PERT" in *this case* by the following reasons:

1) Tracking of schedule every day is very easy and we can easily grasp progress of the jobs at a glance of the bar-chart type schedule, which is not so easy with "PERT".

2) On the PERT, modification and adjustment are rather easy but grasping the situation caused by these modification and adjustment are not so easy.

If we want to grasp-the situation, we usually have to use an output from *computer,* displayed by the bar-chart type, which : costly and takes time,

One of the merits of the PERT is flexibility in its scheduling. But, we think, too-much flexibility in the outfitting control is not always good. Rather, we would like to Say, schedu stiff gives-us good procductivuty in the field of shipbuildingti Because *a* type of scheduling such as outfitting jobs composed of *their activities which are* not *much* different in importance is liable to cause delay from one to next, like the domino, if the the schedule of the key events is left flexible, which should be fixe for keeping total schedule.

Consequently, we can say that the shipbuilding scheduling by the bar-chart type is better than by the PERT type.

CHAPTER V - APPLICATION OF PALLETIZATION

IHI members had a observation of the destroyer tender under construction at the pier and discussed feasibility of palletization at NASSCO. And we noticed that the palletization is applicable to the engine room and the protection deck we observed And if the unit outfitting method is applied, productivity can be improved without much difficulty At the same time, we found that:

1) These compartments seem to have enough room for application of the unit outfitting method. (Sometimes it requires wider room than for the conventional method)

2) Arrangement should be more production-orienteci.

   a) Piping should be grouped and run close to machinery which are major parts of the unit.

   b) Piping should be run as straight as possible and parallel *to the* grating.

   c) Pipe bending angle should be limited to 90 degree, 45 degree and so on. (Sometime th s, . production oriented arrangement can be done at the sacrifice of the function oriented arrangement)

   d) Some machines which are installed closely shall have common foundation instead of individual ones.

3) The unit outfitting method is effective for the engine room and on-block outfitting for the protection deck. (Especially for ov head outfitting)

4) The pre-outfitttig method does not seem *to* be so effective for tl accommodation spaces because completion of jobs (eg. installati of furnitures1) at early *stage* and protection of furnitures from damage during hull construction are difficult.

*L) Because the hirthes have to be fixed both on the deck and the ceiling.

Complete application of the palletization presupposes complete orgzni tion which is production-oriented and prepared for the palletizazion.

On the way to the final target, the organization must meet with many problems and difficulties, especially in getting people to have *right* understanding and consensus for new system. For example, even a draft has to know What does *this MLF mean?" or "How* does delayed issue of M affect to the production?"

It would result in confusion in many fields to try to implement pallet zation in full scale from the very begining. Instead, if implementa- tion of the palletization is so planned as to expand graduaily from small portion ship-by-ship, for example, engine room for the first ship, engine room and protection deck for the second ship and so on, t implementation will be successfully accomplished without my big trotil but with solving problems by your hand on the way.

The gentle implementation would be better than the rash implementation.

CHAPTER VI- RECOMMENTATION PREPARED BY NASSCO

For reference, we attach hereto the document "PALLETIZATION" which is prepared by your Program Management Office based on our presentation as recommendations to NASSCO's top management.

Followings are the contents.

1. DEFINITION
2. RECONMENDATIONS
3. IMPLEMENTATION PLANT
4. PALLETIZATION FLOW CHART
5. SCHEDULE CHART (REINED)
6. SCHEDULE CHART (DISCU_SED)

PALLETIZATION

1. DEFINITION

Palletization is simply a concept to organize materials as they will be used i the shipbuilding process. Implementation of a palletization system demands kn ledgeable preplanning at the very onset of a contract. It is this detailed ad vanced planning by experienced shipbuilders that provides the following benefi

a. An advanced bill of material organized to facilitate earlier procureme

b. Visibility for zone outfitting, i.e., on-unit, on-block, and on-board.

c. Integration of information between departments (Engineering, Productic & Materials).

d. Defines production responsibility (lead trade concept).

e. Results in production oriented drawings reflecting the most economical shipbuilding methods (composite drawings).

f. Collects specific outfitting materials necessary for production person to complete a defined increment or work (work package).

g. Assures consistency of all schedules from the top, down.

2. RECOMMENDATIONS

That NASSCO adopt the IHI palletization concept as outlined herein by appointi a committee to develop system procedures & documentation. Concurrently to sys development, it is also recommended that the principles of palletization be ap to the T ARC 7 contract to a limited degree to include only the machinery spac the auxiliary machinery space and the accomodation areas of the ship.

3. IMPLEMENTATION PLAN (system development & application to T ARC 7 Contract)

a. Establish a committee with the following responsibilities:

- o Develop format for advanced & final bill of material
- o Determine pallet size & pallet numbering system.
- o Assure compatability with existing systems.

o Act as Chairman for palletization meetings l

0 Develop standard practice & system documentation.

0 Assure consistency with all current company policies and procdures.

0 Institute training to assure all departmets *are* suffciently indoc-trained with the principles & goals of palletizaiton

o Study applicability to Carlsbad & AD-44 contracts.

0 Monitor departments for compliance to plan.

b. Engineering

0 Develop arrangement drawings & system diagrams.

o Prepare advanced bill of material (MLS) from system dia.grms *Advanced* B/M's by SYSTEM by ship zone will result in earlier procurement 0f materials

0 Design Engineers to develop preliminary composites for each zone to determine system routing. Preliminary composites to be used to determine candidates for "on-unit" and "on-block" construction. Organize meetings with production engineers/planning department to determine "on-unit" and "on-block" construction.

0 Develop final composite drawings.

0 Develop system drawings from final composites, if required. Develop supplemental working drawing for "on-unit" and "on-block' construction as required by production.

o Prepare final bill of *materials.*

0 Investigate restructuring of Engineering Dept

c. PRODUCTION/PLANNING & PRODUCTION CONTROL

o Establish a production engineering group. Advanced planning accompl by a combined effort of design and production engineers requires a thorough understanding of economical shipbuilding methods. Palletiz of material (purchased and/or manufactured) requires the following i mation:

1. Zone - <u>Where</u> does the material go within the ship?
2. Trade - <u>Who</u> installs the material? Who is responsible?
3. Stage - <u>What</u> stage of construction is the material installed?

Competent production engineers will provide the answers to the above questions thereby assuring the most efficient construction methods. Therefore, the production engineer will -

o Define and schedule the contents of the pallet. Pallets to be struc (as indicated above) by zone, by lead trade, and by stage of constru Lead trades are defined as:

Shipfitter - hull structure, miscellaneous outfitting items.
Pipefitter - piping systems.
S/M fitter - ventilation and selected outfitting items.
Machinist - machinery installation.
Electricians - electrical
Rigger - rigging

o Review and approval of preliminary and final composite drawings. Gen Superintendent to be responsible for preliminary and final composite drawing approval.

o Develop the lead trade concept. By definition, each pallet would as trade responsibility. Palletization provides a clear understanding responsibility and authority.

o With assistance from the facilities dept., develop an "on-unit" cons area staffed with the required trades reporting to a single supervis

- o Structure all material in the SPARDIS system in accordance with the pallet concept, i.e., zone/lead trade/stage of construction.

d. MATERIALS

- o Develop material "lead time" history for establishing preliminary bill of materials (MLS)
- o Define (with assistance from the facilities dept) requirements for a marshalling area, possibly two (2) adjacent areas; one for purchased material and one for manufactured parts.
- o Palletize and issue material.
- o Develop awareness of the importance of the material schedule. Palletization concept will function only if all materials are in the shipyard when needed by production. Missing materials must be minimal.

4. ADDITIONAL RECOMMENDATIONS/ASSUMPTIONS

Additionally and in support of palletization, the following recommendations and/or assumptions are provided:

a. That NASSCO significantly increase "on-unit" and "on-block" construction. A prerequisite for "on-block" construction assumes:

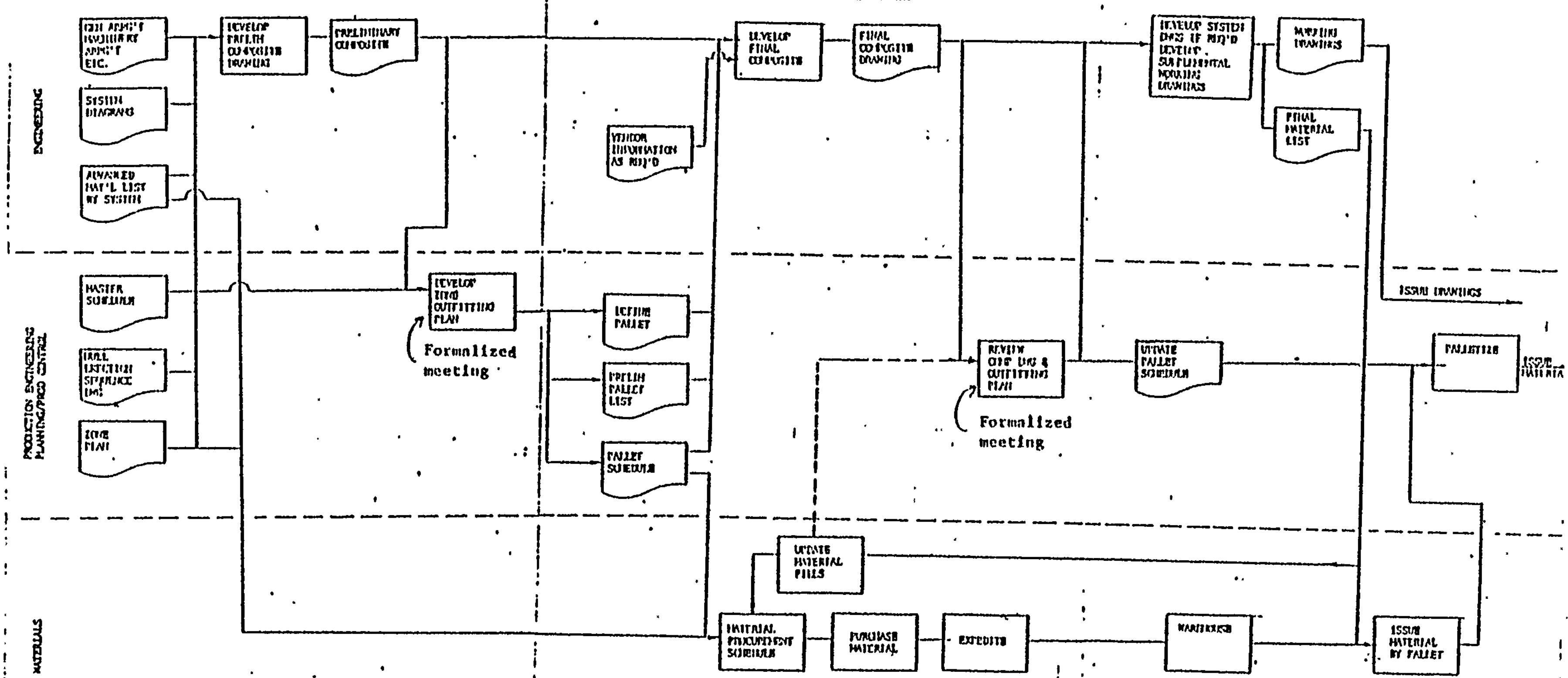
1. Construction of large three (3) dimensional hull blocks suitable for pre-erection outfitting
2. Implementation of Accuracy Control

b. Development of Standards

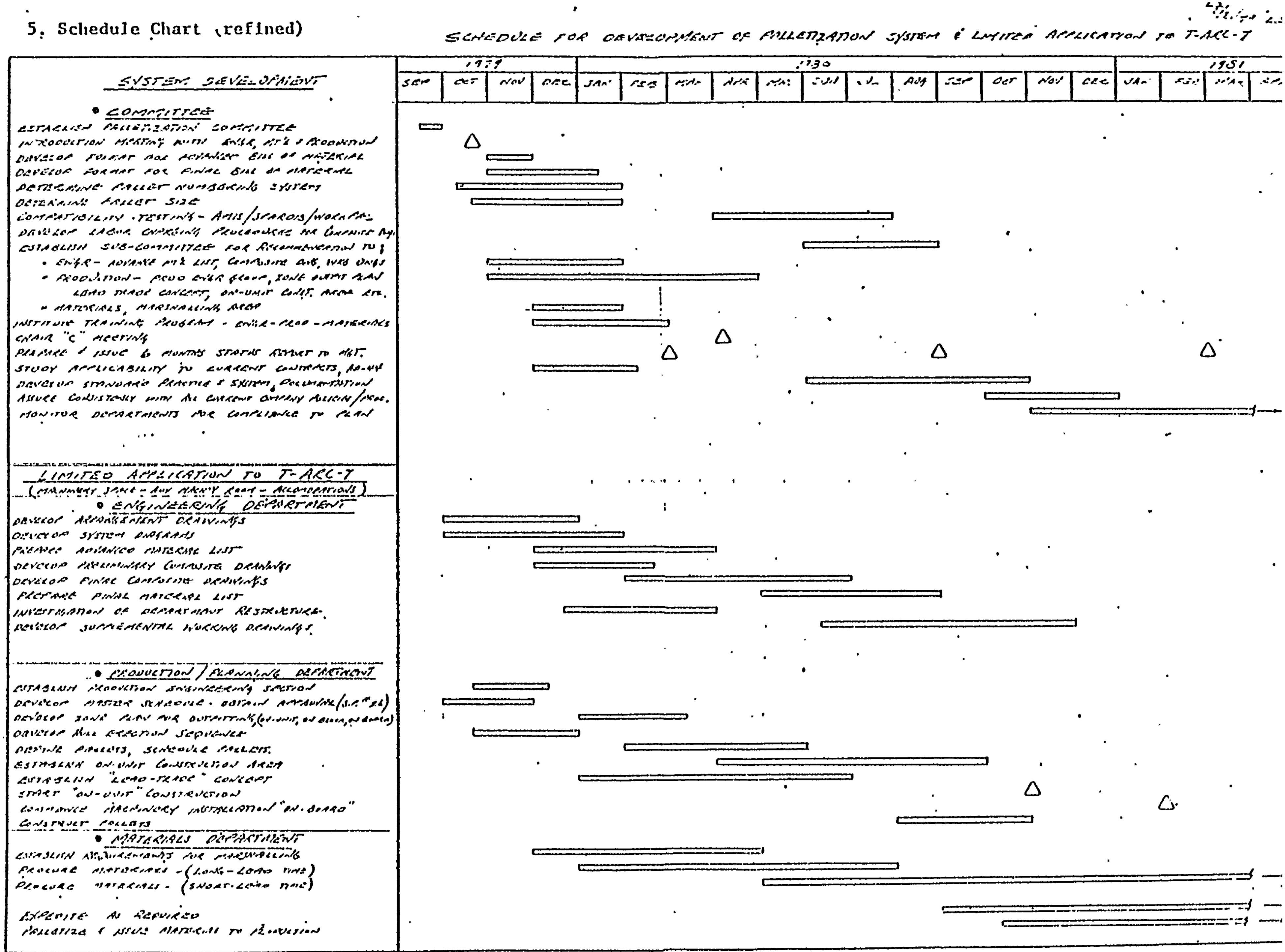
c. Develop a policy for vendor selection, i.e, evaluate total cost (including production labor) to shipyard.

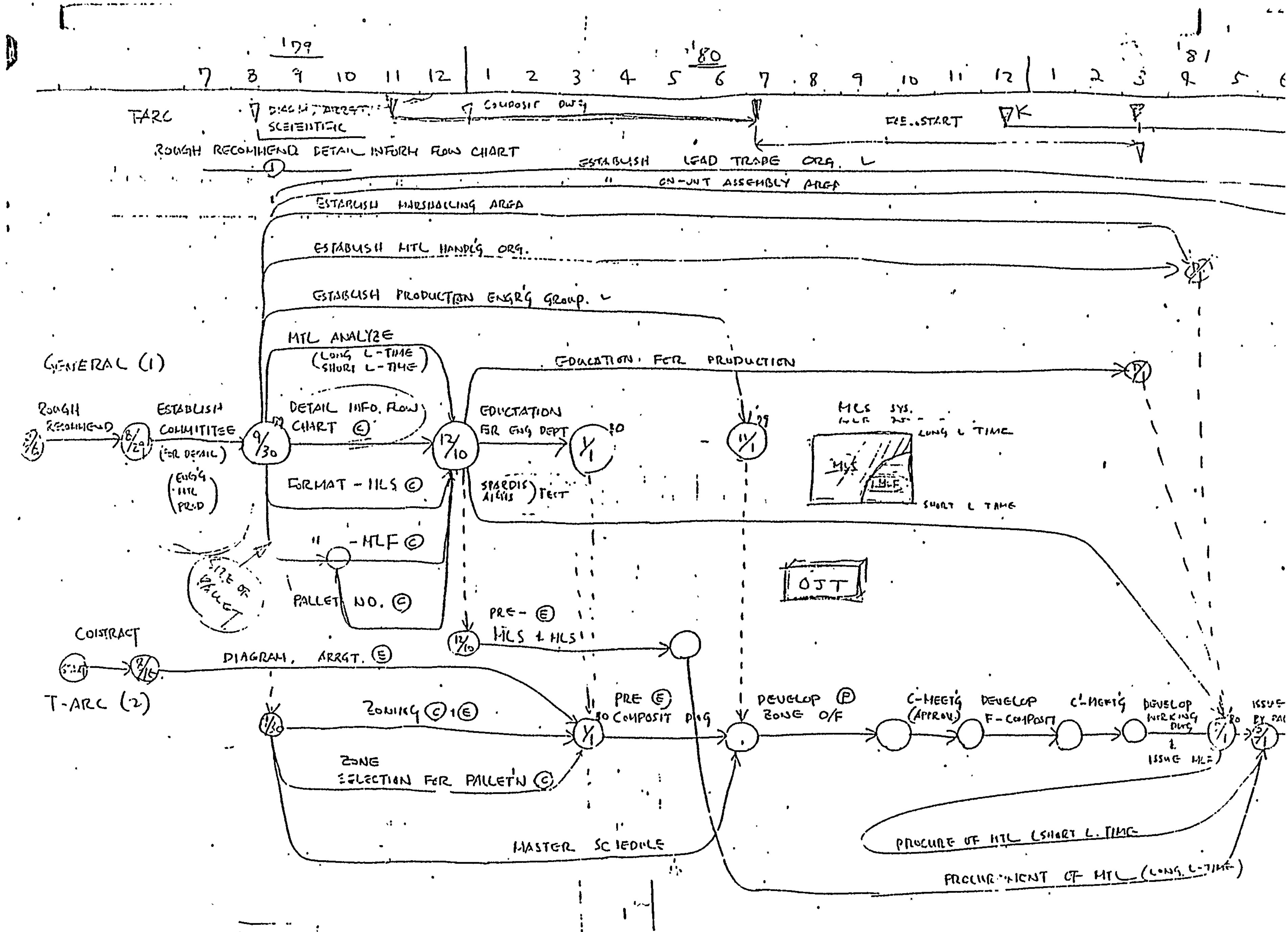
d. Investigate IHI's pipe piece program.

4. PALLETIZATION FLOW CHART



5. Schedule Chart (refined)





6 Schedule Chart (discussed)

STUDY REPORT ON SHIPBUILDING
FOR
NATIONAL STEEL AND SHIPBUILDING CO.

Volume V

- A SURVEY REPORT ON SHIPBUILDING
PROCEDURE. AT XASSCO

November, 1979

Ishikawajima-Harima Heavy Industries Co., Ltd.

TOKYO, JAPAN

A SURVEY REPORT ON SHIPBUILDING PROCEDURE AT NASSCO

A SURVEY REPORT ON SHIPBUILDING PROCEDURE AT NASSCO

1. PREFACE

This report was made by IHI in accordance with the NASSCO Purchase order No. 90997 ..... Item 4 "Dispatching IHI's Engineers to NASSCO".

The survey at NASSCO was conducted from August 16, 1979 through August 28, 1979 by IHI team headed. by T. Ishibashi and accompained by S. Kohtake and . . K. Noguchi.

The survey for improvement focussed on the production field as the source of the shipbuilding business among many aspects such as sales, purchasing and many others. The survey was done through the observation of the shipyard and hearing from the related personnel of NASSC0.

2. THE LAYOUT OF THE SHIPYARD

The area of the site at NASSCO (145 acre) is about 1.5 times as large as that of the IHI-KURE (96 acre) and it is wide enough to maintain its steel fabrication of 7,000 tons per month. However the storage area of materials and completed hull unit were found not being well-arranged. Planning and administration for usage of the site area including transportation should be improved.

It is important in this subject to harmonize the long ranged planning (for several years) and the short ranged operation (weekly or daily). Therefore IHI-recommends to reinforce the responsible organization for better planning.

#1 Daily storage schedule for completed hull units and pallets even scrap bags.

Following are the problems found on the layout.

2-1) Building dock and building ways

It would be better to shift both the houses with roof and the area .for scaffolds located at the dock side to another place, because the covering area of the cranes for erection is useful for units storage.

The sheet iron shop fabricating ducts and vents can be easily shifted to the side of the shipyard or the outside of the shipyard since they are light and easy to carry.

Taking account of advantage to keep enough storage area, assignment of the building dock and the building ways is recommended to follow the next priority : #1 building dock ⟶ #3 building way ⟶ #4 building way/#2 building way. Because following this sequence, both sides of the building dock or the building way can be effectively used as the storage area for the completed assembly units and as the area for pre-outfitting.

2-2) pipe shops

The present flow of pipe fabrication at NASSCO is discontinue because of being separated. In order to raise its productivity, it is recommended to rearrange those shops so as to make the smooth flow from the storage area of pipe material through the area for pipe pallet.

2-3) The flow; of hull construction

The process of parts fabrication and unit assembly of ship's hull is rather long and complicated. In order to simplify the process, the following studies are suggested.

2-3-1) To establish the idea of "Sub-assembly" and to set up the specialized. "sub-assembly yard" :

The "Sub-assembly" referred herein means "small assembly" before as-

sembly such as web frames girders and large brackets with stiffeners.

To keep the specialized "Sub-assembly yard", work shops for bollards and, ladders can be shifted to another place out of the fabrication shop.

In addition, taking account of smoot transportation, the stock yard for small subs and semiprocessed goods which are located at the opposite side of the assembly area in the . fabrication shop ; should be shifted to the nearer place.

2-3-2) Bending rollers and press machines

From viewpoint of adjusting the work load for bending machines, it is recommended that these machines are gathered to the same place so far as smooth production, flow is not distubed.

Present layout at NASSCO for this field is needed to rearrange in consideration of implementation of Line Heating Technology. For that improvement, Some dynamic Simulation. and study based on the volume of the work load are requested. Regarding this IHI can assist if ordered.

3. FACILITIES

Following matters on the facility should be carefully studied as well as the improvement of working practice and layout IHI recommends to make use of IHI's experience and achievement.

3:1) Implementation of the One Side Welding equipment for a flat panel unit

Since there are merits and demerits depending.on the welding method as described below, careful study and selection is.necesary.

Adjusting and operating the equipment require certain skill. Repair works are sometimes requested after welding. Edge preparation at the welded surface requests a certain level of accuracy.

Alternate method should be considered in the time of its machine-down.

- selection of the welding methods should be made comparing. their merits and demerits :

  o FCB Process
  (Flux Copper Backing one side submerged arc welding)

  o RF Process
  (RF-1 Flux one side submerged arc welding)

  o FAB Process
  (Flux Asbest Backing one side submerged arc welding)

IHI recommends to adopt first FAB process for which no additional equipment is needed.

- In Japanese shipyards, the one side welding was adopted to prevent the building for plate assembly yard from becoming high for turning over the panel as the size of unit becomes larger and to establish the conveyer system.

3-2) Implementation of the EPM system (Electro Photo Marking systen)

3-2-1) Characteristics or the EPM system:

Since the EPM system brings high productivity per area, it is suitable for the shipyard of which site area is narrow. in addition, the EPM seems to be the best machine to transfer the information amd data for production such. as edge preparation, stiffeners location, plate thickness shifting direction, stiffeners fitting angle, leg length of stiffeners welding and many others as well as parts name. This characteristics is especially effective for repetitive construction. From such reason, many Japanese shipyards installed the EPM system, which is still in now use.

However, the implementation of the EPM to HASSCO is not aggresively recommended by IHI from the following problems.

3-2-2) The problems of the EPM system :

- Since optical projection érror is unavoidable, the vital dimensions such as the depth of floors are needed to be checked after the EPM process.

- In order to keep clear pictures, uniform quality of drawn lines on the negative films are required. For that, a NC drafting machine is indispensable. The drafting machine at the Mold Loft of NASSCO is not adequate, therefore a new machine should be installed.

- The chacters and lines are scn=-times projected ambignously on the steel plates which are not treated with shop primers.

- its running cost is not cheap, because the spreading powder (called photoner) is expensive.

- The computer program for drafting is needed to add some features in order to make EPH system effective.

  Some additional burning tools by hand should be prepared such as : straight guide rails, magnetic tracers and semi-automatic burning tools.

- There are several combinations as the total EPM system with conveyers and platform cars. In order to select

the type and to install the system, a deep study for layout and production process is required.

3-3) Implementation of Pin-jig system

The Pin-jig system is the most fundamental to fabricate a curved shell unit in high grade of accuracy. The existing pin-jig system at NASSCO is urgently needed to be improved.

The Pin-jig system can be also used with the Multi-burners Line Heating Machine. IHI has the same type of the Pin-jig system at the Tokyo shipyard. IHI recommends for NASSCO to install this type of the system. With respect to this, more details are presented in the chapter 6 of this report.

3-4) The NC frame bender newly developed by NASSCO

Since the NC frame bender newly developed by NASSCO was not yet in practice, it is not easy to state any comments at this moment. However IHI recommends to confirm the following matters before practice.

- Accuracy at both ends of a bent frame because these parts can not be accurately bent by its theory. Concrete counter-measurements for that and shaping method after the process should be established.

- The control of the neutral axis of plastic deformation

Checking method after bending

3-5) The existing NC burning machine

For accuracy control of pieces, following should be confirmed :

Investigate the nachinery accuracy, record and adjust

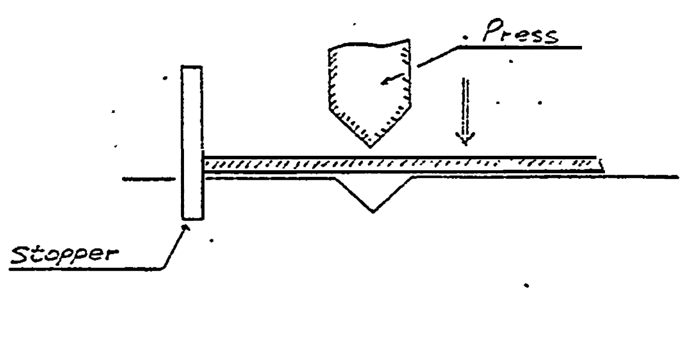
Establish the Maintenance procedure . and execute

Consider the nesting scheme and cutting sequence to minimize deformation by heat distortion

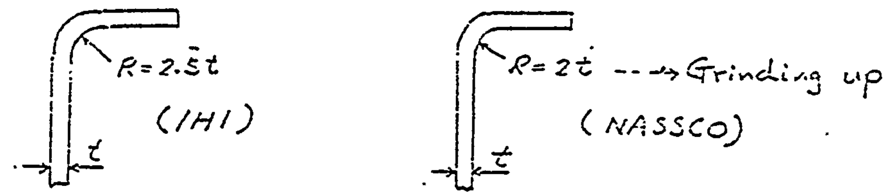
Study to change the marking equipment from "Center-punched marking" to "LINE narking"

3-6). The existing Flange Press Machine

To set the flange edge stopper for higher grade of accuracy.



To prevent lacking at the flange corner, larger radius is recommended.



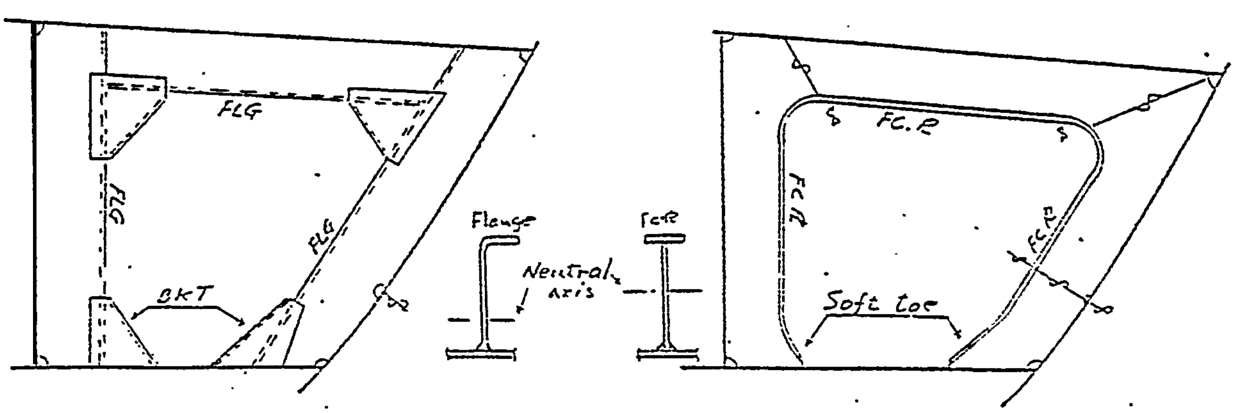
- Standardize design of flange and stand-ardize production practice

4. ENGINEERING

4-1) Design structure of ship's hull

Flange system is one of the characteristics of design structure of ship's hull at NASSCO. IHI ceased to apply the system twenty (20) years ago except at flange bracket but adopts the face plate system instead by the following reasons. From viewpoint of structural design, the face plate system is superior to the flange system. :And the face plate system can save weight to keep the same strength compared with the flange system. In addition; the face plate system has another merit that the location Of erection joint can be decided more flexibly for easy shipwright comparing with flanged girder connection.

The flange system may be cheaper than the face plate system for NASSCO at present. Because no welding Work at the face plate is necessary. However it is recommended to adopt the face plate system instead of the flange system from the reasons described above



FLANGE system (NASSCO)   FACE PLATE System (IHI)

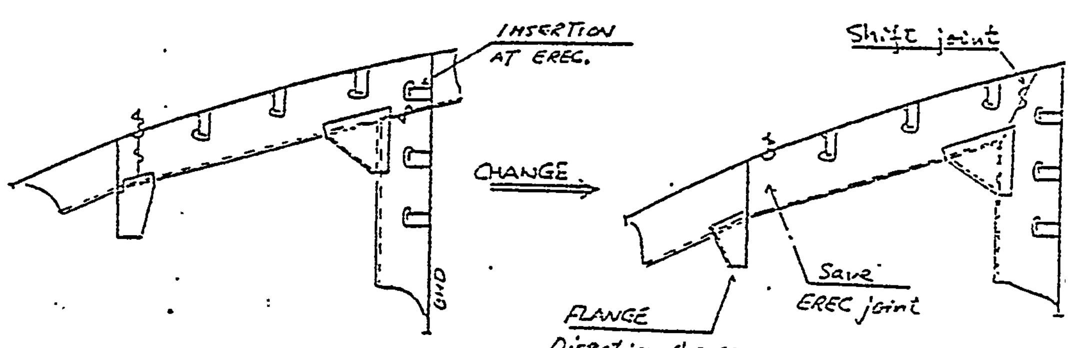
4-2) Working drawing

From the viewpoint that working drawing is to display the structure details based on the target as to how to assemble a unit and how to construct ship's hull, the following points are recommended to be improved. Most of following problems can be improved by standardization.

4-2-1) Structure details around the erection joints :

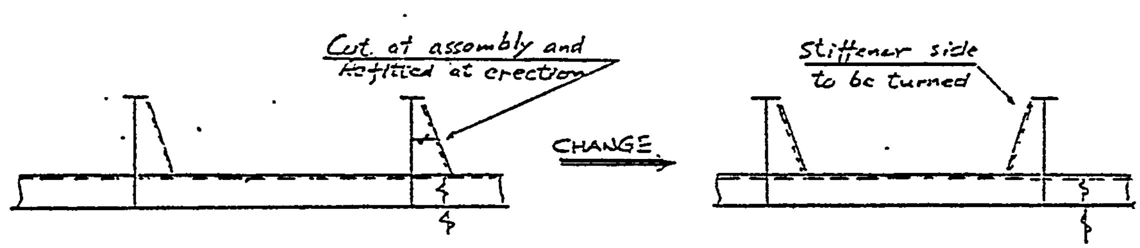
The shift of erection joints between the skin plates and the internal members should be changed for easy connection and for easy shipwright as well as for saving welding length.

Tine flavge direction of the internal members and/or the position of the erection joints at the skin plates should be changed so as to prevent "insertion shipwright" due to inappropreate flange direction.



- The fitting surface of the stiffeners and the brackets to the web plate sh-

ould be selected so as to minimize the short pieces fitted after shipwright.



4-2-2) To minimize scallops :

The scallops should be minimized because of uneffective fillet welding by hand at the corner of the scallops and the convenience of painting. Thefore the scallops should be set in the following limited cases :. the place requested air escape and water stop and the place where welding must be through later.

To solve this problem, following consideration can be available. When all pieces and subs are simultaneously landed and then assembled, no scallops is needed. When some internal members, such as longitudinal frames are welded first and then the other members, such as web frames are landed, corner snips can be applied at the fillet welded part instead of scallops.

4-2-3) The pieces of outfitting" :

- A. large duct in the pump room can be assembled as the part of the ship's hull, because its plate thickness is thick enough (1/4").

- The structure of the bollard can be more simplified. The bottom plate of it has four curved surfaces at NASSCO, however this structure can be more simplified.

4-3) Expression in the working drawings

From the viewpoint that the working drawings should contain only necessary informations in easy expression, it is recommended to review the contents and expressing method of the working drawing at NASSCO, For "that, the survey on "what informations are used by whom and how?" is needed. The tedious expression affects bad effects such as difficult follow to design change, complicated appearance and wasting man hours.

Following is recommended by IHI to simplify the expression in the working drawings.

Establish expression standard and issue the standard booklet to be referred by its users

- Build the standard in the computer program for the thorough application

- Describe the promised symbols in the working drawings

- Example of the concrete objects

  - o Leg length of fillet welding
  - o Welding method
  - o cutout (slot)
  - o End shape of stiffeners and sections
  - o Type. of valve

4-4) To install the computer program of Pipe Piece Drawing and Pipe fabrication

IHI has developed a series of computer programs of pipe fabrication. Using the calculation results of the Pipe Piece Drawing, editting of the fabrication lot, making the cutting plans and scheduling of pipe fabrication are now in practice. The input work for the Pipe Piece Drawing program from the piping arrangement plan is very easy to learn.

It is recommended to study installation of the computer system together with the planning of the new pipe shop and palletization.

5. COMPUTER SYSTEMS

Many big computer systems are now used in many fields. The computer program itself can be seen in high grade so far as computer technology. However its applying method for practical use based on the actual production process should be improved. Those. system shall be fruitful when the following problems are solved.

5-1) Improvement of output

Much computer output sheet were found being piled up without being refered. Distribution of output sheet should be limited since many display terminals have been already installed and through which necssary information can be inquired at the required time.

For easy reference, output should. be expressed in the form of ban chart and curve graph as much as possible instead of alphabet and numbers.

5-2). The system to be more production oriented

To make the computer system fruitful for its users, the system should. be more production oriented. Taking SPADES system and the scheduling function of SPADES a examples,a few problems are pointed out as follows :

5-2-1) SPADES system :

SPADES is to be the nucleus sytem to support the hull construction field. According to further investigation by

IHI engineers, each module can be seen generally good enough to cover its primary purpose. However a study of how to use each module is urgently requested to fulfill the needs from accuracy control and line heating technology. It does not necessarily mean to change/ improve the computer program itself but to consider the usage to match the reuest.

- Rearrangement of the Users manual :

  The users manual of the SPADES-system is too general for the users of Engineering department and Mold loft. Because the manual was editted and distributed to the all user shipyards of which design practice, production practice and grade of skill are different from each other. It is natural for the users to have the manual of' their own.

  Especially, NASSCO is going to promote accuracy control and line heating as the basic technology to support accuracy control for curved shell unit. What should be kept in mind here is the fact that these activities are proceeded by the output from.the computer program, SPADES, as the media for information transmission.In other words, the manual for the input data to derive the necessary informations from the system and to include those information in the output is very important. And also through

this activity, the idea for impro-
vement of the system itself can be
imaged up.

Rearrangement of the output :

For the convenience of production, the outputs should be completed by themselves. If necessary, additional informations should be included by hand writing ; it means production people do not need to refer to another reference or another kind of output.

When several kinds of output are needed such .as curved shell assembly on pinjig, those should be put together.

Refinement of the programs for curved shell :

According to further investigation by IHI engineers, the modules of PINJI and PLATDV of SPADES are not necessarily enough for precise development and bending of plates and for precis positioning and checking at plate assembly on pinjig Some of them can be supplemented by using together with. the "Manufacturing Aids" module of SPADES, however the others have to be obligated to add required data by hand.

It is recommended to refine those programs in the future after recognition of the said problems through practice use.

-5_2_2) The scheduleing function of SPARDIS :

The scheduling program at NASSCO was observed to be good enough for grasping the current status of the production process, however it seems not to be practical so far as the function Of planning is concerned. This kind Of system is requested to be a good tool for the production cycle Plan . . . . . . -Do ... >See . . . . ..>Action . -If its usage is not appropriate nor practical, the result brings contusion only. .

For smooth implementation Of the computer scheduling system, it is recomnended that the managers of each level plan the master schedule by himself and trace it by hand. Through this, they can reconize the current status, the capacity the neck points and critical path of their own field. In addition, communication between different levels and between different departments can be easy by adjusting the nester schedules at the time of planning and tracing. After the hand-made scheduling system is well done, the computer scheduling system can be installed standing on the procedure confirmed by the manual scheduling.

5-3) Establishment of the parameter of the work volume .

For grasping the present status and evaluation of the productivity as well as planning

the parameter of the work volume should be selected to be proportionate to the actual work volume as possible.

Weight is the only one parameter for hull construction at NASSCO but it is not. enough to express the work volume. IHI recommends to use it together with another parameter expressing welding works such as welding length and weight/volume of welding deposite metal. (IH1 adopts deposite meter). This parameter should be selected So be easy to calculated by the computer program with simple input data from the drawings.

5-4) Piece mark system (Code system)

The drawing number, piece name and stage code are expressed with many numbers of alpha-numeric character. These code are too long to write at every phase from making working drawing through the final product. In fact, following was observed in the production field :

After welding of the name plate to pipes, the code for piping system and assembling stage are additionally described with a pen.

Piece name is written in the small pieces of Ship's hull with a pen. It is difficult to write in the 1/10 scaled film for the EPM if NASSCO installs the EPM system: .

IHI recommends to make short the code system by the following study:

- o To use the code in the plural levels
- o To give a. certain significance to the code (promised code) -

"If this change of the code system is not easy for the computer system, conversion between the nominal code for human being and the original code for the computer can be performed by a simple computer program. This method makes the system change minimun.

6. PRODUCTION METHOD AND WORKMANSHIP

Recommendation in this chapter are very vital and will surely contribute to high productivity if applied at NASSCO

6-1) Hull units Of Fore and Aft parts of-a ship.

Larger units should be adopted for the curved fore and aft parts of a ship.

NASSCO has;facilities enough for *ha-idling the* larger units of same size with the *ones* of parallel part of :a ship now being handled. ‘Application of larger units to decrease “number of units will conspicuously save erection manhour and, in addition, assure easy and effective pre-erection outfitting on block. For smooth application of the larger units to the curved parts, however, higher. accuracy in fabrication and assembly together with simplification of erection joints for easy erection are indispensable, which presupposes accuracy control based on standard design.

6-2) category of Hull units and Assembly Yard

Hull units should be categorized into foloWing three.by uniquencess of their st-.ructure or assembling method.

(A) Flat panel unit. : A- unit mainly composed or flat panels to be jointed together on the platen.

(B) Curved panel unit :: A.unit mainly composed of curved panels to be join-

ted together on the pin jigs.

(c) Three dimensional ': A unit other than above (A) and (E) or -a combination unit of (A) and (B)

The idea of subassembly is recommended to establish.

The assemblhy yard shall be arranged according to the category of hull units and subassembly. Tine assembly sites for the curved panel unit and three dimensional unit are - compatible but. the site for the three dfifiensional unit should be located nearer to the erection site (births or docks).

<u>The assembly site for units of same category shall be concentrated to one area and not be scattered widely over two or more areas within the shipyard.</u>

Master assembly schedule should be so planned in accordance with above categories of units as to level the work load at each fabrication and assembly phase as much as possible. Then, work load for fabrication such as planer cuttings,No cutting, plate bending, frame bending and subassembly will be leveled concurrently. Even. if complete levelling of work load is difficult, the irregularity in the density of work load at each phase must be minimized by appropriate- allocation of resources, which will naturally result in higher productivity.

In case on-block outfitting is applied, the period for the outfitting should be reserved and expressed in the master assembly schedule for preparation of pallets.

The master schdule is vital for shipyard operation. But reliable raster schedule can not be made without accurate estimation of practical work volume. The planners of master schedule must be Familiar with procedure of assembly work at site especially In relation to resources allocation.

6-3] Flat panel Unit assembly . . .

Accuracy control for fbrication. of internal structural members . and horizontal flatness of the assembly platen are important.

We noticed overhead welding by workers lying on their backs for flat panel units which is of low efficiency and can be avoided by appropriate ordering of assembly sequence.

High accuracy of assembly can not be achieved without horizontal flatness of the assembly platen. The measured inclination of inch per 20 feet of the NASSCO's platen must be improved as soon as possible.

6-4) Curved Panel Unit Assembly

The size. of a plte for the curved shell units should be larger.

The size of plate now applied at NASSCO is too small especially for bow and stern parts where small plates requires much joint wel-

ding v:hich can be reduced by adopting larger -plates.

For more effective assembly of units, a plate must be larger and more complex benting such as longitudinal or twist bending should be applied. 'Line heating is a technology for this purpose and most effective when applied after bending by roller which is very effective for cylindorical bending but not applicable to multi-directional or twist bending which are most neatly done by line heating.

To apply more complex bending to larger:- plates, the bending templates currentltly used at NASSCO Should be modified because they are only for transverse bending and not applicable to longitudinal or twist bending. For precise bending, the templates with sight line (edge) introduced in the text book of line heating are recommended.

IHI has studied SPADES system in detail and devised a program to develop templates with sight line from the data given by SPADES which will be introduced to NASSCO at your request.

Next we refer to jigs.

We observed discrepancies between jigs, shell plates and frames to be jointed together which are caused by difference in curvature of shell plates and frame due to inaccurate bending. The workers forcibly align the plates with frames and weld them together. This requires considerable hour of unnecessary

work, degrades accuracy of unit assembly and makes erection work difficult . When there will be discrepancies between jigs, plates and internal members like frames, of course, the jig Should be the base. The accuracy of jigs is fundamental and vital for construction. of hull units, which presupposes;

- Pin jigs of stable and tough structures
- To confirm that the data for jigs are fair and correct and to check the actual setting conditions of jigs with the confirmed data
- To assemble hull units in conformity with the confirmed.jigs.

Nevertherless, if there exist discrepancies between jigs, curved plates and frames, accuracy of materials or calculation method by computer should be ckecked.

AAcomputer program based on interpolation method such as for fairing of shell curvature, may commit errors in some cases and careful study and through understanding of the contents are necessary for adopting a new program. Wnen discrepancies among jigs, plates.and frames exist, they must be cleared by through probe into the reason thereof.

6-5) Three Dimensional Unit Assembly.

For better accuracy control, prior study should be carefully made as to selection of checking points or lines for right positioning of members or assemblies consideration of sequence of assembly work.

Planning of scaffolding should be made in connection with this study.

6-6) Straightening of Welding Deformation

We Iding deformation at unit- completion is conspicuous. The deformation should be straightened at each phase of subassembly and assembly. Total deforamtion at completion of a hull unit and reforming manhour will be minimized if the deformation caused at each phase is straightend before next phase even through another deformation will be caused at the next phase. Straightening at each phase ensures easy accuracy control and minimizes erection manhour, which should be the first target for improvement of productivity.

6-7) Cable Wiring on Board -

Electric cables wired in the machinery space of the ARCO tanker under outfitting did not appear neatly wired because they snaked at random. Introduction of wiring winch for electric cables is studyworty.

6-8) Piping in the Machinery Space

Piping in the machinery space was not so well organized because one system of pipes are installed independently from other system regardless of outfitting sequence. Pre-erection or unit outfitting will improve this condition to much extent.

6-9) Painting

Painting is very good. However the parts to

be welded after erection of units such as block joints or foot parts of pillars under the girders of machinery flat etc. should be protected by masking tapes.

We learned that NASSCO was studying introduction of weld through shop primer and would like .to mind you 'to pay attention to the demerits. of the primer as undermentioned as well as its merits.

Usually, clients are very nervous about painting and many troubles are expected about touching up of damaged primer

- Gas cutting speed should be lower for the primer coated steel plates and, in case of fillet welding of high tensile steel, blow holes are liable to remain in ihe deposit metal.

Removal of fume generated by gas cutting or welding must be considered because modern primer has tendency to contain zinc.

Our frank opinion recommends NASSCO to conserve the conventional surface treatment by sand blasting which is very effective for the time being while 1eaving introduction of the shop primer to future study.

7. CONCLUSION

We pointed out several items for your improvement in the production system in previous chapters. We believe that these items are all important and applicable to: NASSCO by themselves but we do not think that these improvement should be started simultaneously because they right bring you some troubles or confusions, at the beginning,: by: the people who have not been used to the new method. We, therefore, recommend you to start the improvement from very few items which are essential for reducing manhour, as explained in the preceding chapters.

Note :. So far as we studied in NASSCO, the total production manhour of ARCO tanker is approximately twice or three times as much as that of IHI. We notice that some of manhour would be easily reduced if some of the major points are successfully implemented. Since the cost accumulation classification and method between NASSCO and IHI had many differences, a manhour comparison in detail was not easy.

7-1) Hull Production

In the hull production, the improvement should be concentrated to <u>the unit assembly stage</u> at the beginning.

In an attempt to improve the whole shipbuilding productivity, an improvement for the hull production is more effective than for the outfitting, because the hull production consumes a great dea1 of manhour in whole for the shipbuilding.

And also rationalization of a hull production system is easier than that of an outfitting system because the hull system is not complicated such as the outfitting system which containes several number of sub-systems and. is only a single system. Especially, the improvement should be concentrated to the unit assembly stage because it calles inevitably for improvement of the preceding and following stages ie, the fabrication and erection stages.

The most of Japanese shipyapd made improvement successfully by the same way. Their experiences emphasize the points such as ': :

- A feed back system shall be established for self-improvement of system.
- The implementation shall not be rushed.
- All the relevant people shall be well educated for new system.

Outfitting

In tile outfitting, the improvement should be. concentrated to the unit outfitting in engine room primarily and the zone outfitting method secondarily.

Through our observation of the destroyer tender in NASSCO, we noticed that the unit outfitting method is applicable to this kind of sophisticated engine room. It means that the unit outfitting method is probably applicable to all engine rooms which NASSCO constructs. You can repeat the outfitting of the same zone (engine room) by the same

method so thet NASSCO people may be easily used to it and expand its application to the other zone. It is also a merit for this recommendation that the units such as a pump unit, a purifire unit, a pipe unit etc. can be assembled in less dependent to the hull . constriction schedule. Therefore it gives hull production less damage even through we have some troubles upon new outfitting method.

The implementation for on-block outfitting method should be started only after the hull unit assembly stage under being improved becomes steady. Because it is very dependent on the hull unit assembly schedule and has fears to get the hull production into trouble.

In connection with punctual material preparation which must be very serious problem in U.S.A., IHI has total material supply system which prepares materials to a shipyard in package and with the.schedule to meet with their construction schedule. It has been applied successfully to several foreign shipyards. It must also be nelpfull to better material procurement in NASSCO.

7-3) Feed Back System

For successfull implementation of the aboves, a feed back system is indispensable. It shall provide the following' functions.

- Defects and inconveniences in production site are to be reported surely and punctually to relevant organizations ie.

Design engineer, Material expediter, Planning engineer etc.

-.Proposals for improvement or creative idea for production are to be transimitted to the relevant organizations.as a routine job.

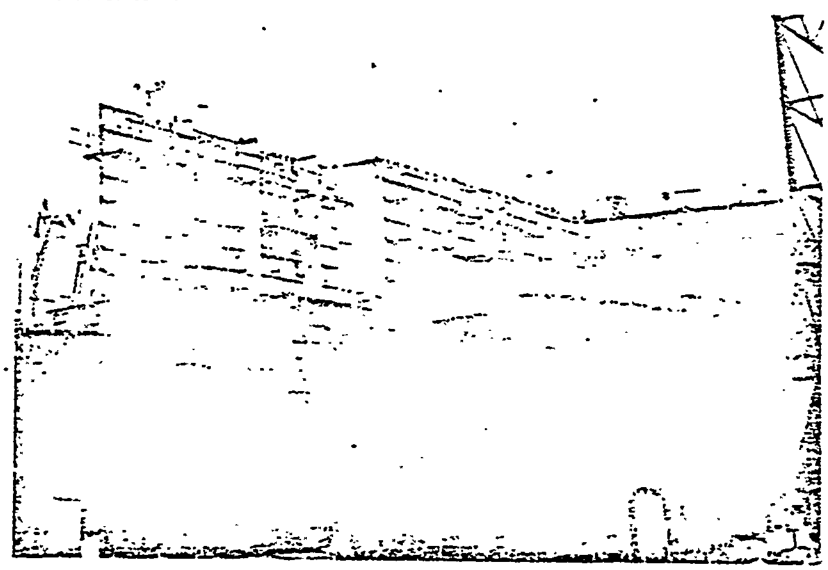
They are corrected by and to a special group who make evaluation and decision for their acceptance and plan for realization for each item.

- "Result of each implementation is checked by the group and fed back to the relevant organizations.

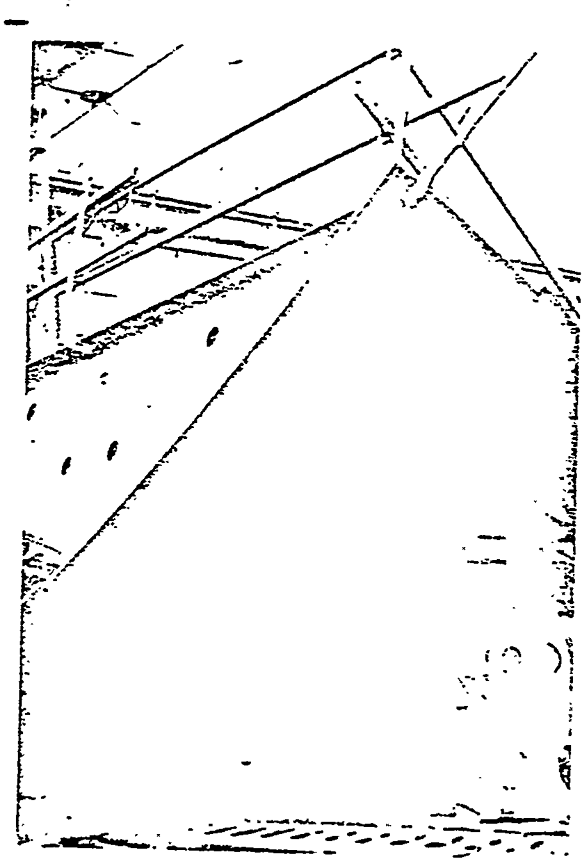
This group composes two sub-groups; for hull and for outfitting. Each sub-group should be assembled by the members who belong to various sections in relation to hull production and outfitting. The Group should belong to Production Planning Group in Yard operation Department. If IHI has a chance to dispatch engineers to assist for t-he implementation of the accuracy control and palletization in NASSC0, they should join. to this group.

At the end, we would like to inform you that we could make a recommendation for optimum productive capacity in each yard based on the data of your yard facilities which you gave us and an assistance for the future planning of whole NASSCO shipyard which you might have if you give us the request.

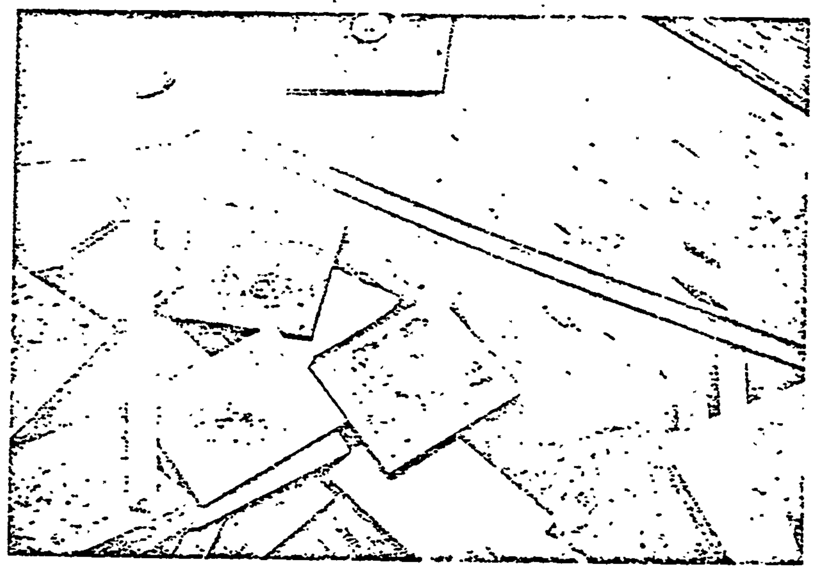
We appreciate your kind cooperation and hospitality given to us by Mr. French and the other members.



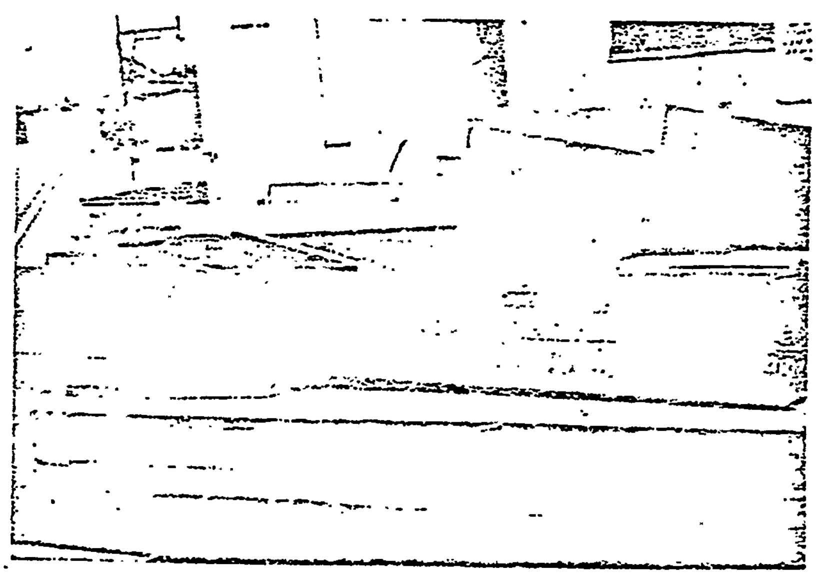
Small and many numbers of units require more manhours at erection

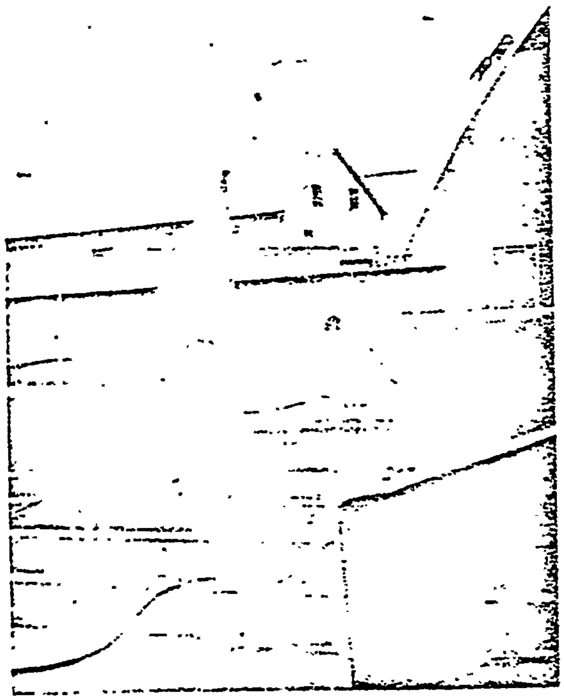


Smaller pieces of curved shell plates require more man-hours to assemble and weld at assembly



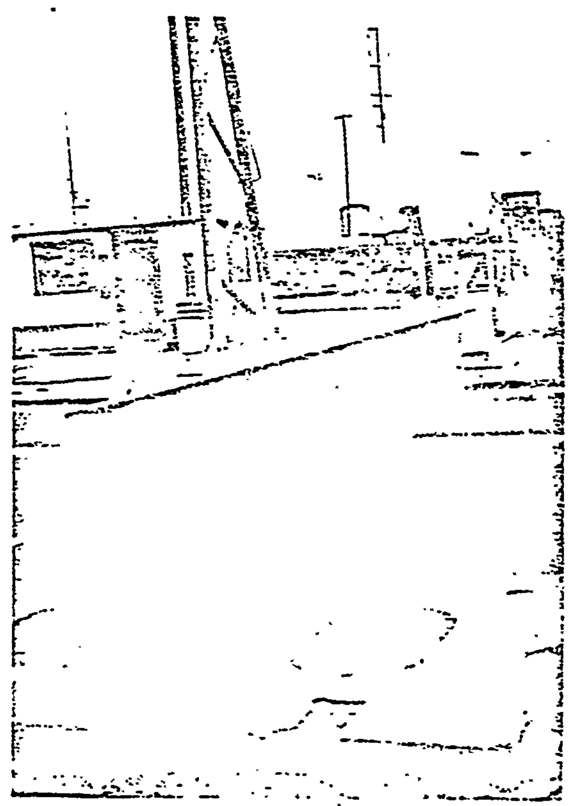
The parts code system is complicated. (Number of digits of NASSCO's piece mark is approximately three times of IHI's one)





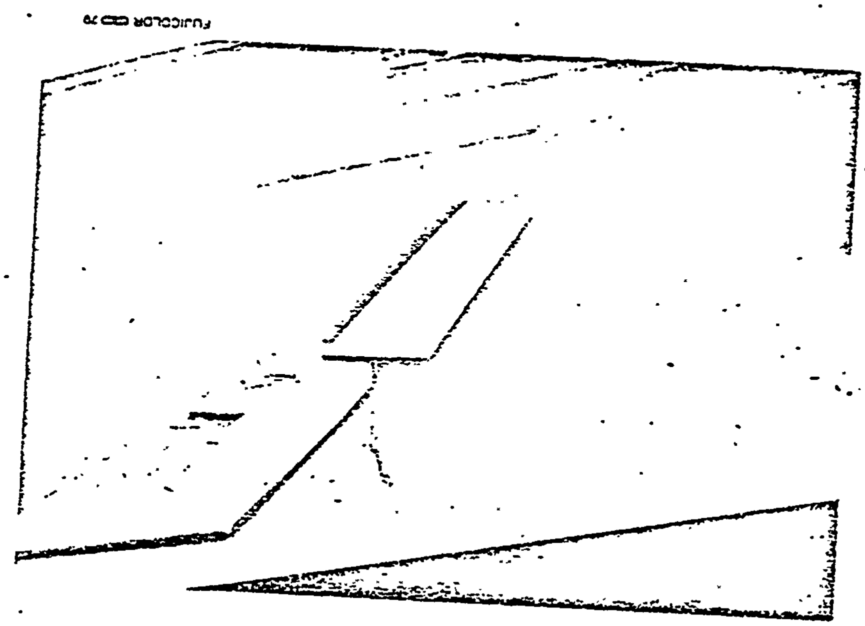
The idea of "Sub-assembly" stage should be established.
Here "Sub-assembly" means "small assembly".
The bracket in the picture can be welded in down hand at "Sub-assembly" stage on the flange web frame and then landed together at assembly.

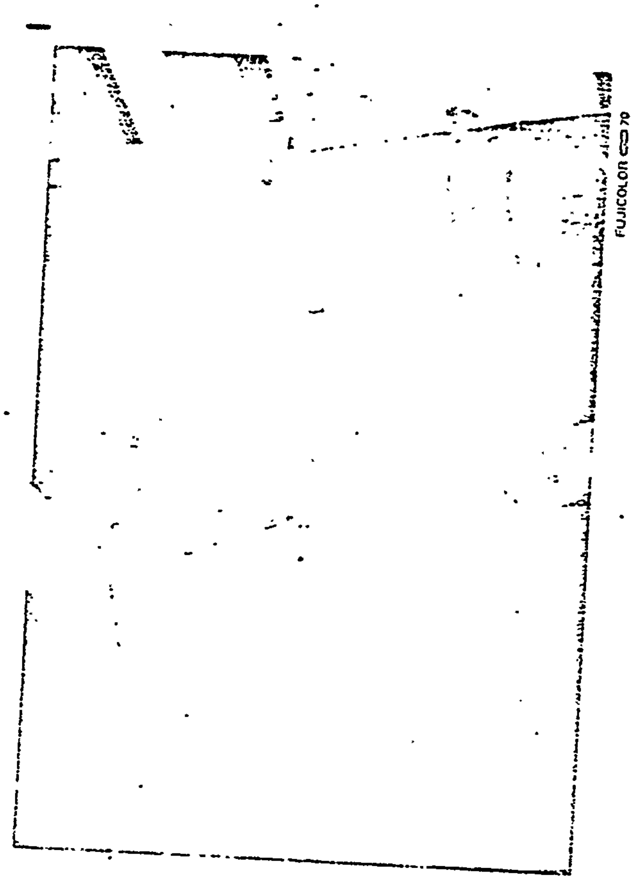
Brackets and stiffeners on a flange web frame can be sub-assembled by down hand welding beforehand.
Then the sub-assembled web frame can be landed and assembled.
Thus most of welding can be easily performed by down hand welding through the establishment of "Sub-assembly" stage.

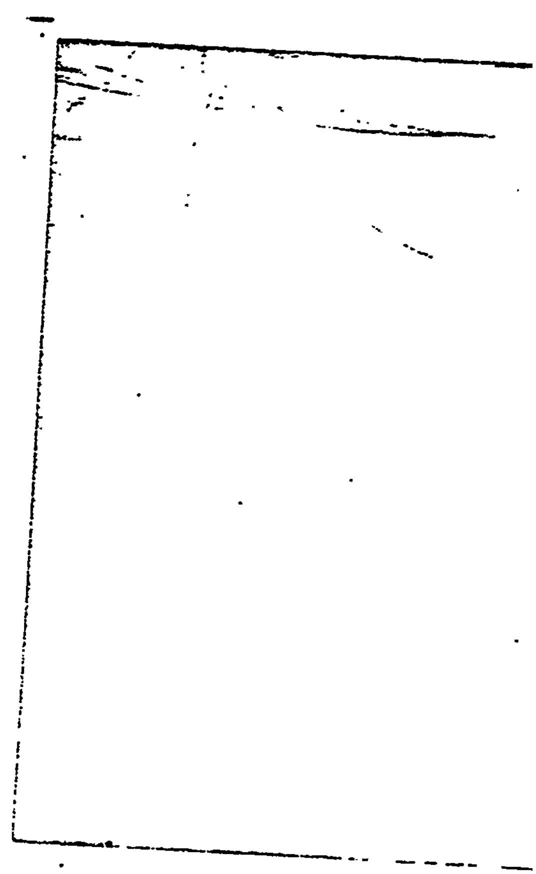


dock long

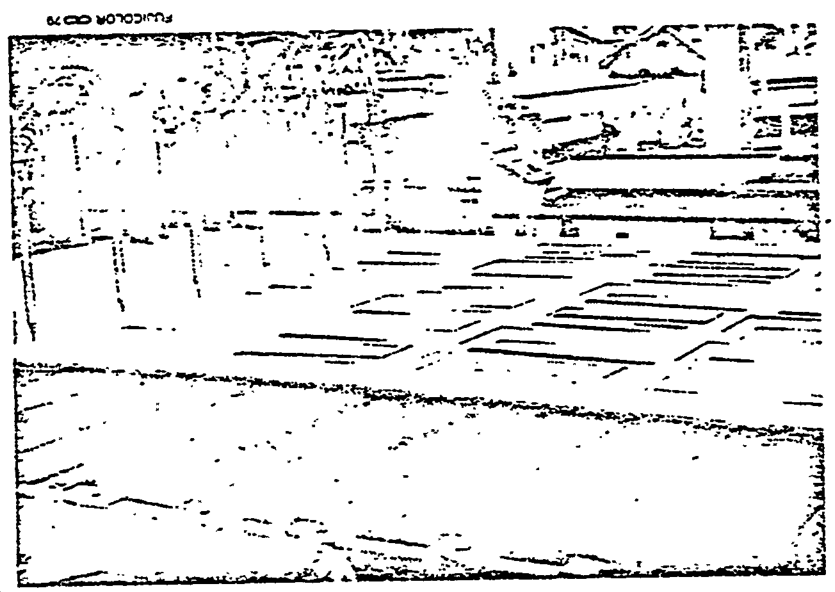
T-shaped carling is inconvenient to welding works. Flat bar is recommended instead of T-shaped piece since enough strength can be kept for the purpose. (IHI adopts flat bars for carling even in 250,000 DWT tankers)



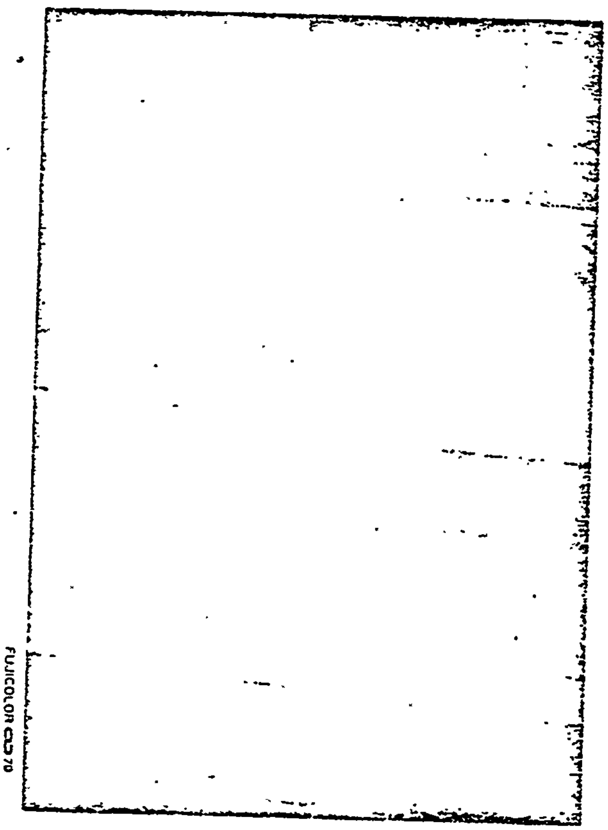


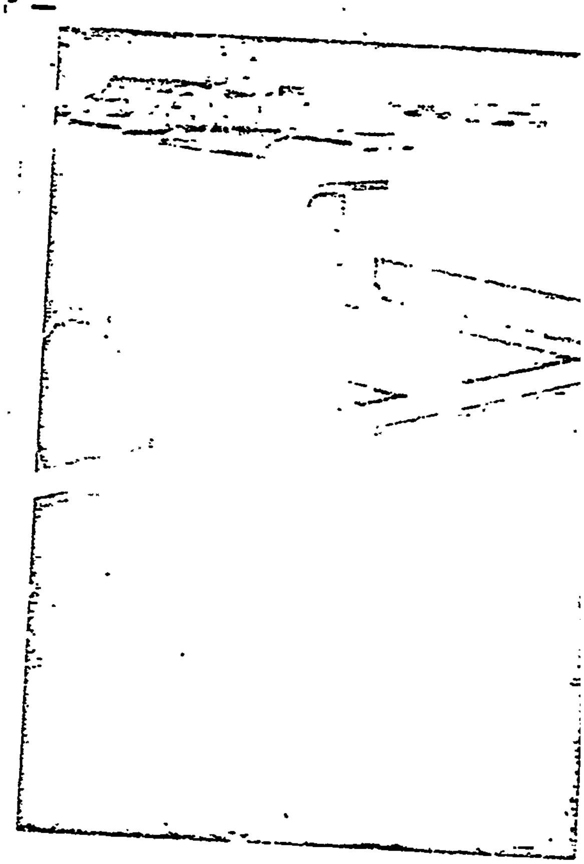


Cutting small pieces by the optical tracer from a large plate as shown in the pictures may bring high productive gas cutting, however .this kind of small pieces. is recommended to De cut from scrap plates to save material.



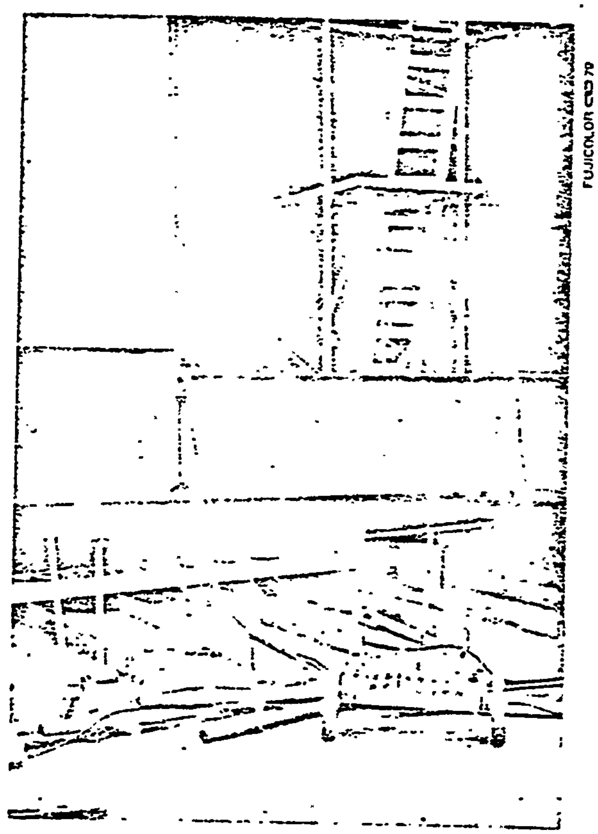
Insert work at erection is very difficult. In order to prevent insert work, the curtain plate (margin plate) of the bulkhead should be included in this unit. (Design change)

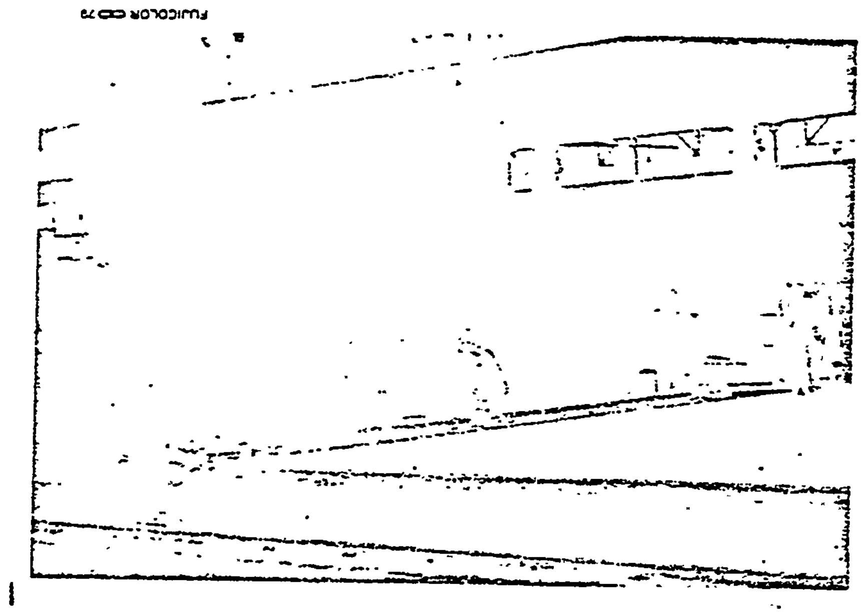




The problem around the connecting part between two flange frames can be solved by the change of the flange direction and/or the change of the position of the erection joint.

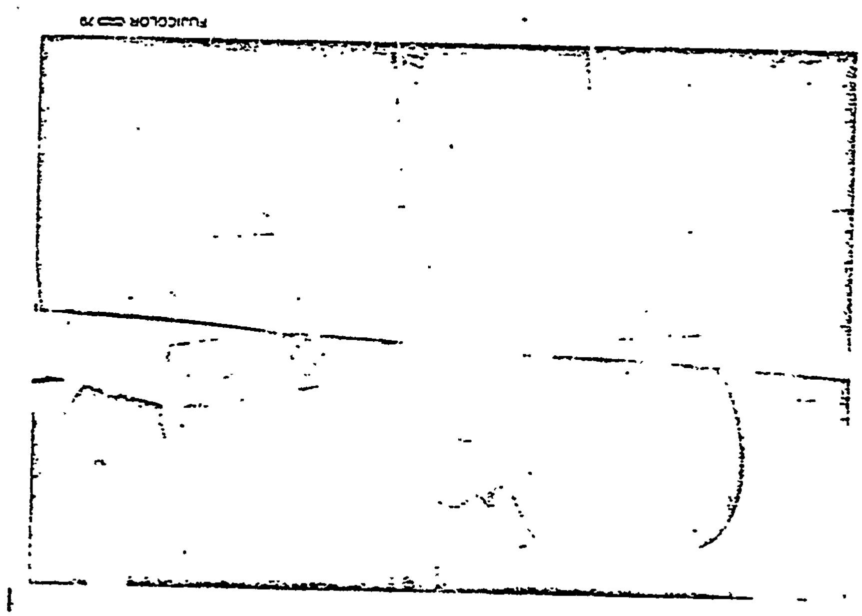
The position of the erection joint
should be shifted.





Insufficient engineering

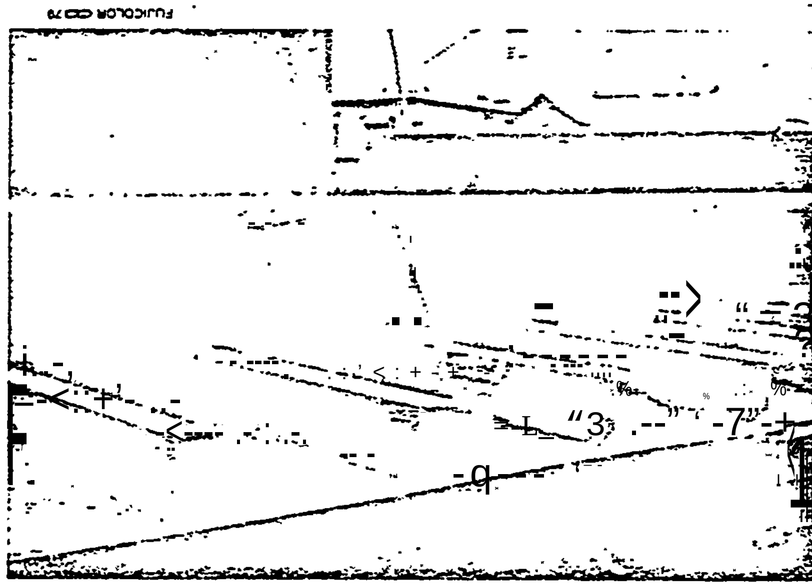
Brackets and that bars are obliged to be gas cut and the parts gas cut of piece are temporarily put near ther After erection, those are rewelded. This kind of reworks were caused by poor engineering. It the stiffeners are fitted to the opposite side of the web plate, the vain reworks can be prevented.



Necessary scallops are not opened. (Poor engineering)
Scallops for erection welding should be opened at the flange webs.

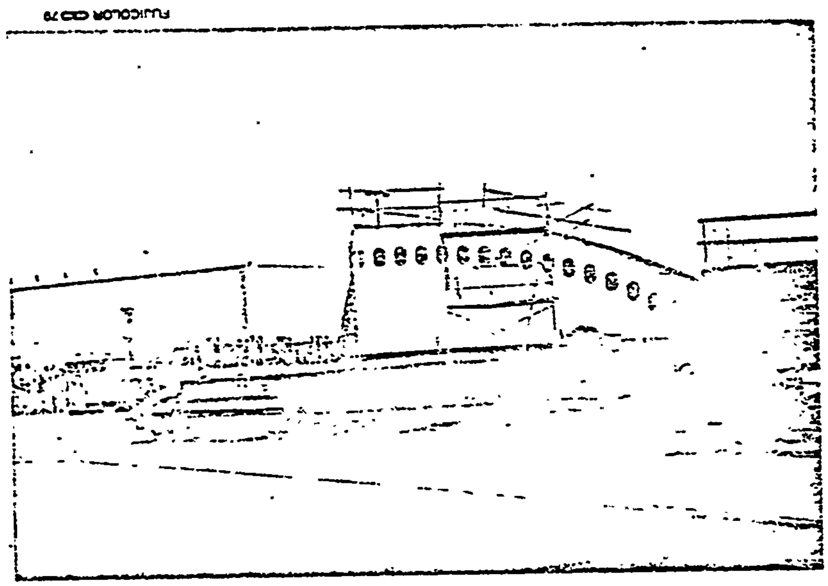
Cutout mis-opened. (Engineering)

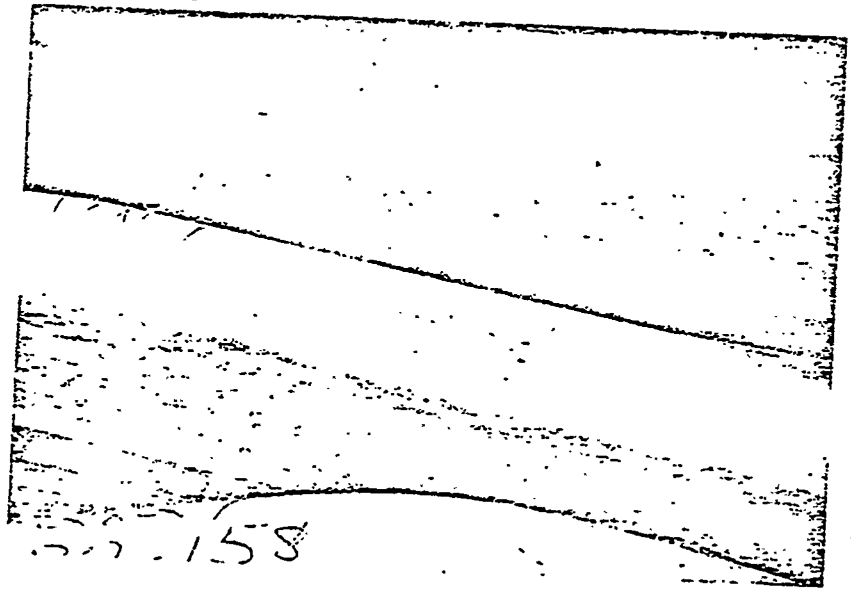
If the bracket is sub-assembled to the flange web, the wrong cutout could be checked by match mark for fitting BKT at the cutout before gas cutting.



Position of access holes (Engineering)

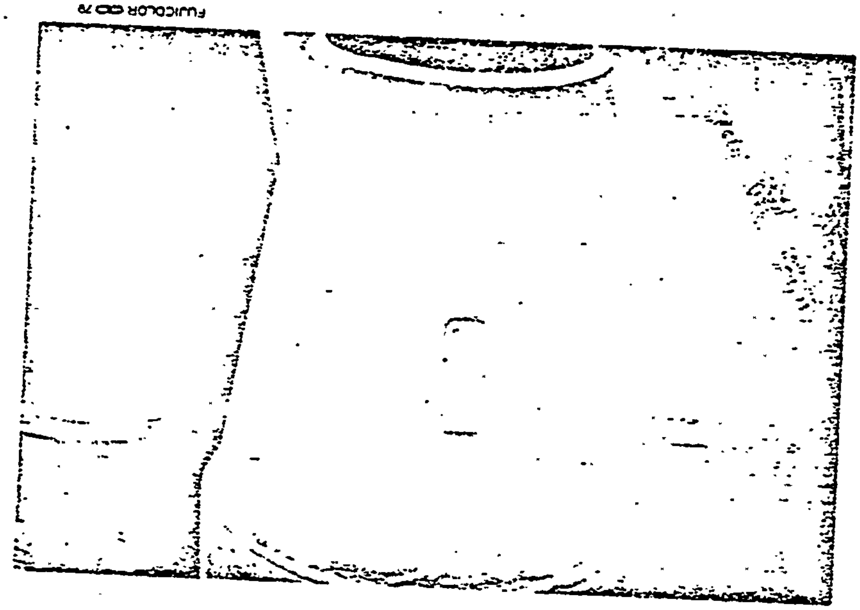
If the position of the access holes are in zig-zag arrangement (the one is near the bottom, the next is near the T.Top), it is more accessible for assembly workers and scaffolding is not necessary.

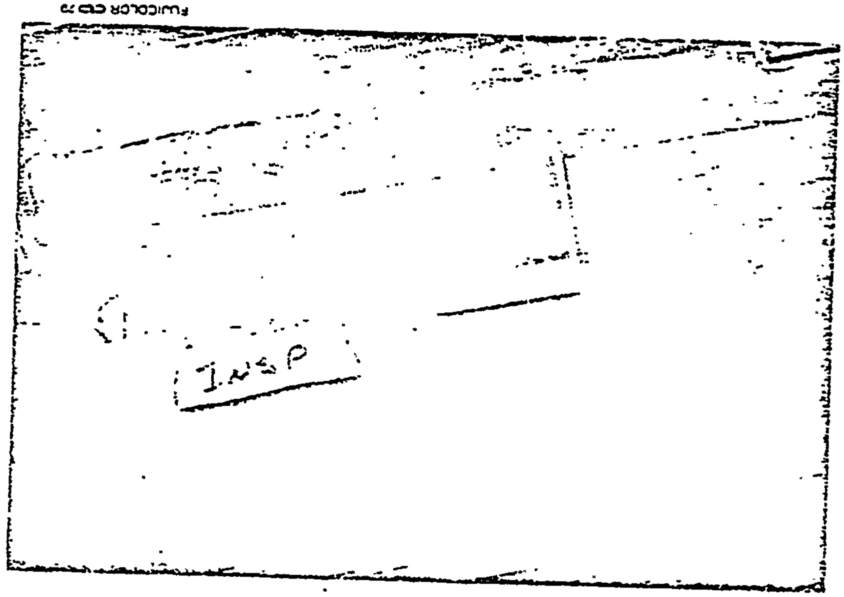




Long pipe pie
code

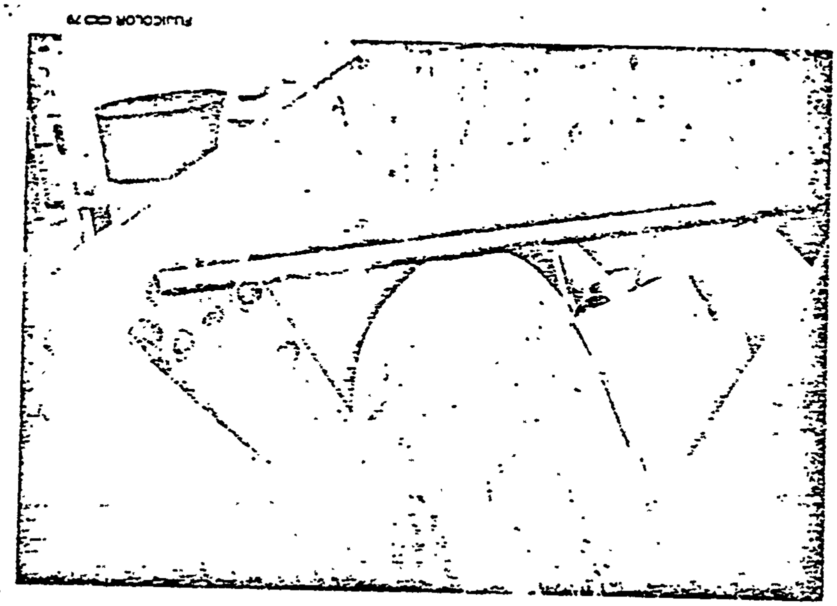
It is trouble
some to weld
name plate to
each pipe pie





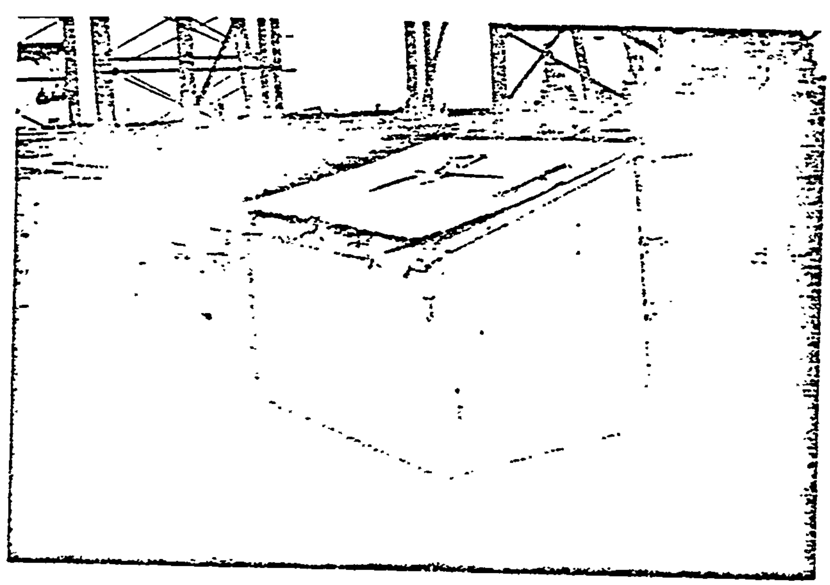
Wasted material (Pipe)

By install of the pipe piece drawing system and pipe fabrication system, pipe scraps can be decreased.



Much computer output sheet

Through improvement of distribution of computer output sheet, output sheet and computing time can be saved.



Wasted material (Electric wire)